NOV 2 1938

NOVEMBER

THE JOURNAL OF THE AMERICAN DENTAL ASSOCIATION AND THE DENTAL COSMOS

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1938

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The Journal of the American Dental Association and The Dental Cosmos. Vol. XXV, No. 11. Published by the American Dental Association, 212 East Superior Street, Chicago, Ill. Yearly subscription $5.00. Entered as second-class matter, March 25, 1937, at the postoffice at Chicago, Ill., under the act of Aug. 24, 1912. Published monthly.

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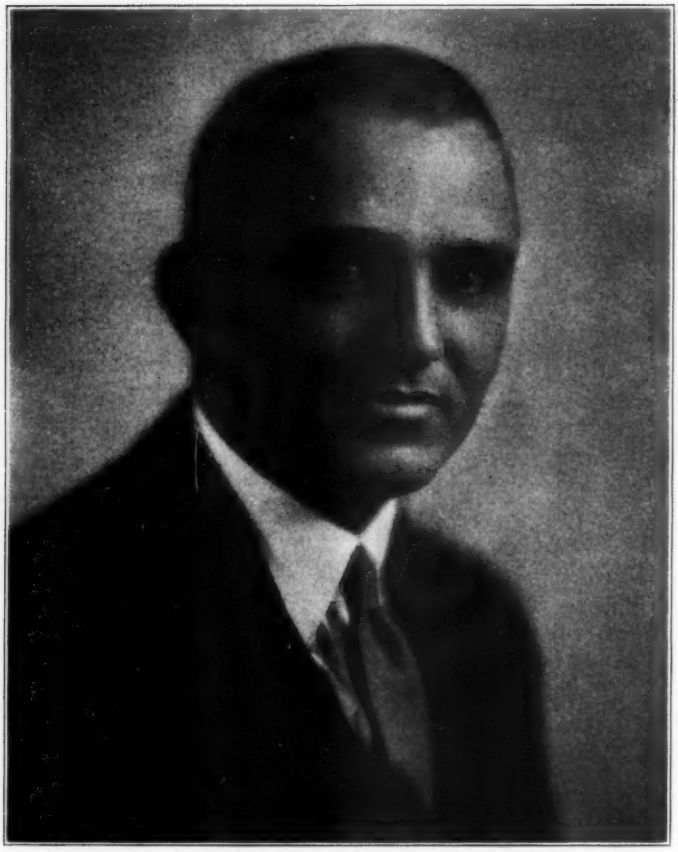

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THE JOURNAL *of the*
AMERICAN DENTAL ASSOCIATION*
and THE DENTAL COSMOS**

*Vol. 25, No. 11 NOVEMBER 1938 **Vol. 80, No. 11

CORRELATING ROENTGENOGRAMS WITH PATHOLOGIC LESIONS OF THE ORAL CAVITY

By Le Roy M. Ennis,* D.D.S., Philadelphia, Pa.

THE ever-increasing importance of focal infection in our modern concept of systemic disease demands a thorough understanding of pathology to interpret more accurately the lesions of focal infection when seen in the roentgenogram. Without this essential knowledge, it is utterly impossible to interpret correctly roentgenograms of acute and more particularly of chronic inflammation involving the teeth and their supporting structures. The diagnostic value of the roentgen rays in inflammatory processes affecting the teeth and surrounding parts is governed entirely by the variation in the density of the hard tissues as a result of the inflammation. In acute localized infection, the inflammatory process being of too short duration to bring about an appreciable amount of destruction of the bone tissue, the roentgen rays are of less value. It is in chronic, long standing infection, or an "exacerbation" of a chronic type, that this method of diagnosis finds its greatest field of usefulness.

Chronic periapical lesions often exist in the absence of clinical signs and symptoms. Roentgenographic examination then becomes the only means of diagnosis. Even in the absence of symptoms, a periapical rarefied area as shown in the roentgenogram does mean usually that disease of some kind is present, unless, as might sometimes happen, the exposure has been made so soon after an operation that the rarefied area has not had time to become obliterated.

The claim has been made that these areas of rarefaction revealed by the roentgen rays are non-infective in the absence of pain and local symptoms and may simply represent the results of previously existing disease that has been cured. In other words, it is contended that they contain harmless scar tissue.

Read before the Section on Oral Surgery, Radiology and Anesthesia at the Seventy-Fourth Annual Midwinter Clinic of the Chicago Dental Society, February 17, 1938.

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Although this possibility is conceded in a small number of cases, the persistence of such a rarefied area for any length of time without a decrease in size is sufficient evidence that a disease process is present. Otherwise, the area would become smaller and be replaced by new bone. There is abundant postoperative evidence that these areas of rarefaction disappear and are replaced by new bone unless infection remains. Postoperative pathologic findings so strongly support the view that these rarefied areas revealed by the roentgen rays are active foci of disease in most cases that it is the wisest course to regard them as diseased until proved healthy; and this rule should govern particularly in the case of invalids.

Fig. 1.—Thickening of alveolodental periosteum in apical region of maxillary second bicuspid. The pulp was putrescent.

Fig. 2.—Thickening of alveolodental periosteum in apical region of mandibular second molar; pulp vital. The condition, which is evidently due to trauma, is often seen in the apical region of the mandibular third molar.

Roentgenographic examinations, checked by subsequent extraction of teeth or surgical treatment and followed by histologic and bacteriologic examinations, show that, from a clinical and pathologic standpoint, dental diseases which constitute focal atria may be broadly grouped into two classes as an aid to diagnosis and prognosis: 1. Lesions involving the periapical region of the tooth resulting from infection following death of the pulp. 2. Lesions involving the investing tissues of the teeth—the alveolodental periosteum and the alveolar process—not dependent on the death of the pulp, but in which the infection starts at the gingival margin.

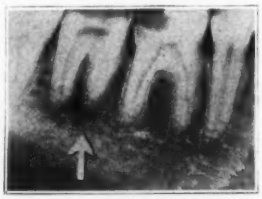

Fig. 3.—Typical appearance of bone when suppurative condition is present. The area is diffuse and it is impossible to locate definitely the periphery of the area.

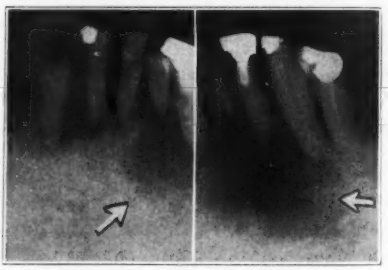

Fig. 4.—Extensive suppurative condition in region of mandibular cuspid and incisors. The rarefaction of the bone is much greater than in Figure 3.

PERIAPICAL DENTAL LESIONS

Periapical dental lesions are the most important with which we have to deal from a roentgenologic standpoint, because they so often occur in the absence of clinical symptoms or signs, and roentgenographic examination becomes the principal means of diagnosis.

In a majority of cases, the disease results from infection following the death of the pulp, the bacteria passing up the root canal and into the apical tissues through the apical foramen. Bacteria may also be carried from other parts of the body by the blood stream and lodged in the periapical tissues of pulpless teeth or of teeth containing necrotic pulp tissue. This infection may follow dental caries or inflammation or death of the pulp; and it may result from trauma or from artificial devitalization. Much has been said as to the part played by various medicinal chemical irritants in the causation of these periapical conditions. The use of such chemicals may be the starting-point, preparing the way for bacterial infection; but that they alone can induce the reactive process which examination of the diseased tissues sometimes reveals as continuing and progressing for years is generally improbable; for we know that the action of chemical agents is limited in duration by the fact that they cannot perpetuate themselves. It is more logical to regard infection by living bacteria as the essential cause of long standing periapical lesions.

Fig. 5.—Acute exacerbation of chronic rarefying osteitis with granulation tissue.

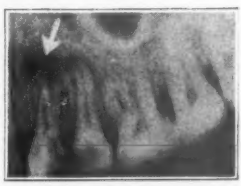

Fig. 6.—Acute exacerbation of chronic rarefying osteitis with granulation tissue. The area is decidedly smaller than in Figure 5, owing to the puncturing of the buccal plate of the alveolar process, permitting the escape of the infection into the soft tissues.

In a study of bacteriologic findings in diffuse and localized periapical radiolucent areas, Burket[1] says, "A diffusely outlined radiolucent area at the apex of a tooth suggests the presence of an active progressive lesion, while a circumscribed or localized area is indicative of a more chronic or latent process."

Fig. 7.—Typical granuloma with compact cancellated bone around periphery of area.

Fig. 8.—Rarefying osteitis with granulation tissue. The affected area is much larger than that in Figure 7.

The original infection in practically all cases of periapical disease is streptococcal. The access of streptococci to the alveolodental periosteum of the apical region causes a typical inflammatory reaction on the part of the tissues, which is de-

pendent on the virulence of the invading organisms and the resistance of the patient. If the streptococcus is of the hemolytic type—of high virulence—and the resistance of the patient is low, the inflammation will be acute and may result in acute abscess formation. If this does occur, with the evacuation of the pus under proper treatment, the condition may rapidly subside, with practically no detachment or destruction of the alveolo-

Fig. 9.—Difference in appearance of two areas about same size. In A, the greatest dimension is mesial-distal; in B, the greatest dimension is labial-lingual.

Fig. 10.—Radiolucent area with greatest dimension mesial-distal. The trabecula of the alveolar process may be seen in the area.

dental periosteum and no appreciable destruction of bone.

In case the invading organism is of the viridans type—of low virulence—the inflammatory reaction is apt to be chronic, giving rise to little apparent disturbance, but slowly progressive and proliferative. The first change seen in the alveolodental periosteum is a thickening of the tissue, which is infiltrated with various blood elements, but especially polymorphonuclear and small round cells, particularly the latter.

The principal stages of chronic periapical lesions giving rise to roentgenographic abnormalities may be outlined as follows:

1. Chronic proliferative alveolodental periostitis.

2. Chronic rarefying osteitis with suppuration.

Fig. 11.—Difference in appearance of areas over two incisors due to their position in relation to alveolar plates.

Fig. 12.—Epithelial cell-rests of Malassez, found normally in alveolodental periosteum.

3. Chronic rarefying osteitis with granulation tissue.

4. Chronic rarefying osteitis with cyst formation.

PROLIFERATIVE ALVEODENTAL PERIOSTITIS

When the pulp becomes infected, there is no change roentgenographically. Not until the infection passes beyond the apical foramen, setting up an inflammatory process in the dental periosteum, do we find any change roentgenographically. As the periosteum becomes swollen, owing to the inflammation, it naturally becomes thickened. Therefore, we see the first change taking place, manifesting itself as a slight thickening of the dental periosteum about the tooth apex, but without any appreciable loss of bone, which is shown in the roentgenogram by an increased thickness of the normal radiolucent line between the apical portion of the tooth root and the bone. (Fig. 1.) However, this thickening of the periosteum does not always mean an infected pulp, as there is the same roentgenographic evidence as in cases of occlusal trauma. (Fig. 2.)

Fig. 13.—Epithelial sheath of Hertwig, continuation of outer and inner epithelial layers of enamel organ.

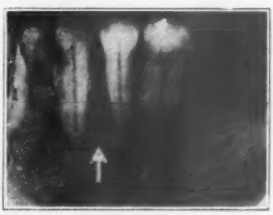

Fig. 14.—Dental root cyst where vitality of teeth was not involved.

Continuous proliferation of the dental periosteum takes place at the expense of the bone of the alveolar process, and, as proliferation of the round cells occurs, the bone becomes rarefied and finally destroyed, the resultant chronic rarefying osteitis appearing in the roentgenogram as a radiolucent area, the abstraction of lime salts of the alveolar process in the affected area allowing the rays to pass through more readily.

Fig. 15.—Residual granuloma developing into cyst.

Fig. 16.—Residual dental root cyst, arising, in all probability, from residual granuloma as seen in Figure 15.

CHRONIC RAREFYING OSTEITIS WITH SUPPURATION

The access of streptococci to the apical alveolodental periosteum usually causes

a typical inflammatory reaction. The streptococcus is of the hemolytic type, of high virulence. In the primary stages, there is generally no roentgenographic evidence, the same conditions existing as in the case of acute osteomyelitis. However, in the chronic stages following rarefying osteitis, the roentgenogram presents a blurred area of somewhat lessened density as compared with the surrounding bone. The peripheral margin of the area, into which the roughened tooth apex projects, is irregular and diffused. The more active the suppurative process, the more irregular and ill-defined the margins of the lesions in the roentgenograms. The infection in this type is to be regarded as more active than in the forms of rarefying osteitis with granulation tissue. (Figs. 3-4.)

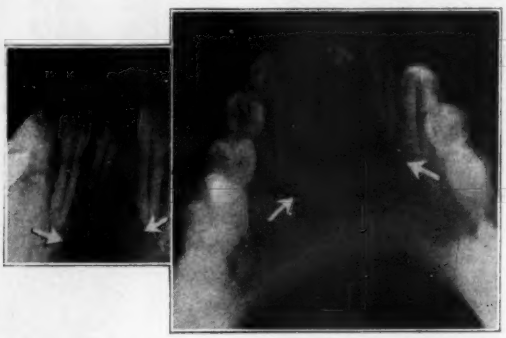

Fig. 17.—Infected dental root cyst in mandibular incisor region.

CHRONIC RAREFYING OSTEITIS WITH GRANULATION TISSUE

Chronic rarefying osteitis leaves this bone space filled with a mass of chronic inflammatory granulation tissue, to which the entirely inaccurate, though generally accepted, term granuloma has been applied.

The granulation tissue is composed of small round cells, polymorphonuclear and endothelial leukocytes, fibroblasts, capillaries and fibrous tissue and masses of epithelial cells, in approximately 50 per cent of cases as shown by McCrea[2] in a recent examination of the granulation tissue, and more recently corroborated by Burket,[3] who found approximately 70 per cent in the cases examined. From this tissue, streptococci may be obtained, both by direct smear and by culture. Sometimes, the granulation tissue breaks down and is replaced by fluid pus, which fills the bone cavity; or the pus may be discharged through a sinus after a chronic abscess has developed; or the area of bone disintegration may consist partly of pus and partly of granulation tissue, combining to constitute an exacerbated condition. (Figs. 5-6.)

In the suppurative cases, a secondary staphylococcic infection usually is added to the original streptococcic infection. Lesions containing fluid pus, however, are in a minority as compared to those containing only granulation tissue, and therefore the term "chronic abscess" is not applicable to the majority of cases of periapical infection.

These areas of bone rarefaction and destruction vary greatly in size. The bone resorption is usually accompanied by slow detachment and destruction of the alveolodental periosteum covering the cementum of the root end, thus depriving the root end of its blood supply and

converting it into a necrotic foreign body.

The importance of these areas from the clinical standpoint is that the contents of the areas, including bacteria and their products, produced by periapical bone resorption, are directly connected with the general circulation through the blood vessels and lymphatics in the walls of the cavities and running in all directions through the granulation tissue;

Fig. 18.—Infected dental root cyst extending into maxillary sinus, but not communicating with sinus. Infection occurred after extraction.

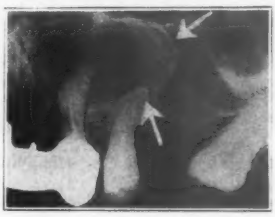

Fig. 19.—Infected dental root cyst pushing anterior wall of maxillary sinus posteriorly.

and although the outer layers of the granulation tissue may be denser and more fibrous than its inner portion, tending to prevent spreading of infection locally, there is no positive limiting membrane in the sense of preventing its contents from entering the general circulation and being deposited in distant structures of the body.

This type has no clinical symptoms and therefore virtually the only means we have of ascertaining its presence is by the roentgenogram, which may reveal the apex of the tooth projecting into the bone cavity, or shortened or roughened from irregular resorption of the cementum, or perhaps enlarged owing to hyperplasia of the cementum. The lesion itself is shown as a more or less clearly defined radiolucent area, varying in size. (Figs. 7-8.)

Fig. 20.—Residual root cyst. (Compare size with that of cyst shown in Figure 21.)

Fig. 21.—Recurrence of cyst after unsuccessful attempt at removal.

The periphery of the radiolucent area may be a wall of compact cancellated bone. This is the typical granuloma. (Fig. 7.) However, in the case of an exacerbation, the radiolucent area may have a diffused peripheral margin. (Fig. 5.) It must be constantly in mind that the radiolucency of the area depends on the content, size and position of the granuloma. For example, if the greatest dimension of the granuloma is the bucco-

lingual, the area will be very radiolucent. If a similar granuloma, that is, one with the same cubic content, has its greatest dimension mesiodistally, it will be more difficult to recognize, because considerably more bone will be superimposed on the area, and it will consequently be more radiopaque than in the former case. (Figs. 9-11.)

Fig. 22.—Dental root cyst in region of maxillary third molar region. The wall of the cyst was broken, with the result that the cystic fluid was discharged into the mouth.

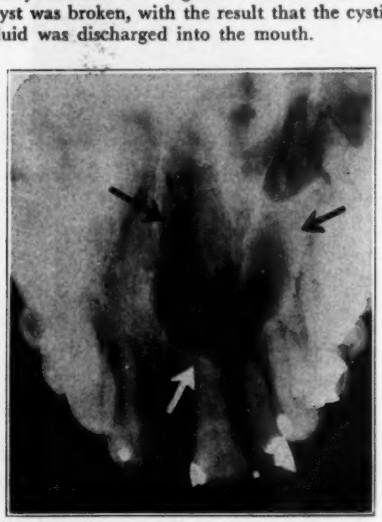

Fig. 23.—Dental root cyst occupying one-third of palate.

CHRONIC RAREFYING OSTEITIS WITH CYST FORMATION

Among the connective-tissue elements of the inflammatory granulation tissue developing as a result of infection about the root apex are found masses of squamous epithelial cells. Similar cells are present normally in the alveolodental periosteum, where they are known as the paradental epithelial cell-rests of Malassez. (Fig. 12.) These epithelial cells are believed to be the remains of the outer cells of the enamel organ, which originally passed down and formed the outer wall of the sac in which the cementum of the root was formed. (Fig. 13.) As previously mentioned, approximately 70 per cent of the granulomas contain epithelial cells.

Many of the areas in the roentgenogram interpreted as granulomas may be diagnosed as cysts microscopically, yet clinically and roentgenographically they

Fig. 24.—Dental root cyst occupying entire palate and associated with carcinoma which extended to base of brain.

are not cysts, and all areas of granulation tissue containing epithelium evidently do not degenerate into cysts. The common theory is that proliferation of the epithelial cells found among the granulation tissue is promoted by the chronic inflammatory process; but this evidently is not the direct cause of proliferation: there is apparently some other factor, either alone or linked with this chronic inflammatory process, which causes the prolif-

eration of the epithelial cells. Often, we find cysts on obviously vital teeth, with no clinical history of an inflammatory process. (Fig. 14.) Perhaps the stimulation arises from trauma or from other conditions of which we have no knowledge. (Fig. 15.) The fact remains that the cells in many cases do proliferate and the mass of epithelium then breaks down in the center, forming a cavity containing fluid. This cyst cavity gradually enlarges because of the continued pressure of the proliferating epithelial cells, causing atrophy of the central epithelial cells. Owing to this continued pressure, the surrounding granulation tissue is forced to the periphery of the enlarging bone cavity; and, eventually, the walls of the cyst consist of a dense fibrous capsule lined with a few layers of epithelial cells. (Fig. 16.) The cyst fluid is usually clear, usually sterile; but infection of the cyst wall frequently converts the cystic contents into pus. (Figs. 17-19.)

Dental root cysts vary considerably in size. (Figs. 20 and 23.) In the maxillae, they may push up the floor of the maxillary sinus or of the nasal fossa, but rarely do they actually open into these cavities. (Figs. 18 and 19.) Recently, a number of these cysts closely associated with carcinoma have been reported, with the suggestion that they may have degenerated into carcinoma. (Fig. 24.)

Usually, the dental root cyst is sterile, its greatest harm being destruction of bone by pressure, a destruction sometimes so great as to cause a pathologic fracture. Such cysts should be recognized and removed in their incipiency. They should never be treated through a root canal by medication, but should be removed surgically, as the entire epithelial wall must be removed to prevent recurrence. Cysts do often become infected after the extraction of teeth by reason of the invasion of bacteria from the oral cavity. (Fig. 17.) We then have a residual infected dental root cyst. It is my belief that a great many residual cysts form after extraction, for the majority of these residual cysts are practically sterile, and contain no pus. (Figs. 20 and 21.) If the cyst were present at the time of extraction, the cystic fluid would escape and the bacterial flora of the mouth enter the cavity, a residual infected dental root cyst developing. (Fig. 17.)

The mere extraction of a tooth when granulation tissue is present is not sufficient. If the tissue is not removed with the tooth, these areas should by all means be curetted to prevent development of a dental root cyst. (Fig. 22.)

Roentgenographically, the dental root cyst appears as a very clearly defined radiolucent area involving the apices of one or more teeth. It may be of any size, but with regular and very sharply defined margins, so that there is usually no difficulty in determining where the healthy bone ends. (Fig. 21.)

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ETIOLOGY, TREATMENT AND PREVENTION OF CHRONIC GINGIVAL IRRITATION AROUND PORCELAIN JACKET CROWNS

By Russell C. Wheeler, D.D.S., St. Louis, Mo.

In conversation not long ago, a colleague and I came to the conclusion that in the majority of porcelain jacket crown restorations, there is chronic irritation of the tissues about the teeth. My colleague remarked that he had seen a patient that morning with several well made jacket crowns on anterior teeth, and in every case there was evidence of hyperemia of the cervical tissues. He was apparently amazed at the fact that such excellent work should show such a poor final result. Every dentist has seen the same thing in his own office, and—what is worse—as a result of failure of his own efforts. It is discouraging to see a jacket crown of one's own design become, some time after it is placed, a continuous source of gingival irritation, when originally it gave so much promise as an esthetic restoration.

Usually, we decide to use the porcelain jacket for one reason only—its appearance. It looks natural, and it is considered the ultimate in dental art. Later, after the crown is made, if there is evidence of passive hyperemia at the gingivae, with the resultant low-grade infection, the work is condemned as a menace to the tooth as well as a complete failure in appearance. Our efforts seem futile when we remember the tribute we paid to this particular type of restoration in making promises to the patient before the work was done. He may have been led to believe that he was to receive the closest thing to Nature's handiwork that had yet been devised in dentistry.

The most beautiful porcelain jacket crown, when finished and placed, and well matched in mold and color, will not look well with a background of purplish, hyperemic tissue. What is even worse, we, if we are conscientious, have to admit to ourselves that the person who put himself in our care would have been better off with a patchwork of fillings in the tooth, which would have left much to be desired in appearance, but would have left unassailed the foundation tissues.

Several years ago, I decided that if I were to continue making porcelain jacket restorations, it would be necessary for me to find out what was responsible for such unsatisfactory results. It was one of my own cases that brought this thought to mind. This case, on which I had complete records including photographs, showed extensive inflammation around the cervical margins. (Fig. 1.) I had previously viewed the case with pride. When I saw the outcome, my ego suffered a complete deflation. I realized then that although the form, alinement, contacts, occlusion and color were good, something very vital had been missing in my technic. What could I do to avoid such gross failure?

Whenever it is difficult to determine the cause of failure, it is usually necessary to make a minute study of funda-

Read before the Section on Partial Dentures—Crown and Bridge at the Seventy-Fourth Annual Midwinter Meeting of the Chicago Dental Society, February 17, 1938.

mental details, in order to find flaws in the procedure. I first made a closer study of the tissues which seemed to be most insulted by my handiwork, namely, the gingivae. I found that much had been added to the histology and pathology of this tissue and its related parts since I had studied the subject. From there, I turned to the study of the fundamental and physiologic form of the teeth at the cervical third of the crown and root. After deliberation, study and "trial and error" experience, I found that I was getting results. I found also that it was possible to fail on any one of several technical steps, even though the remainder of the procedure was correct.

It is possible to eliminate entirely chronic irritation around porcelain jacket crowns. The secret lies in acquiring the proper perspective regarding gingival tissues histologically and learning the fundamentals of tooth form at the cervical third of crown and root, then using that information as a background for a definite, finished technic.

First, I shall review briefly the fundamental studies and then show the adaptations necessary in the various steps of porcelain jacket technic.

HISTOLOGY

In this country, too many of us are still of the opinion that the periodontal attachment at the cemento-enamel junction represents the actual gingival attachment to the tooth at all ages under normal conditions, or at least until the cemento-enamel junction is exposed by recession. That is what I was taught and that is what I once believed.

Gottlieb, of Vienna, was the first to suggest a different situation, in a paper read in Leipsic, Germany, in 1920. Hermann Prinz was the first man in this country to recognize Gottlieb's findings *(Dental Cosmos,* January 1926). In December of the same year, an article on the subject by Gottlieb himself appeared in THE JOURNAL. Since then, I am afraid we have been slow to grasp the clinical significance of those findings.

Prinz writes:

> Up to the present, anatomists regarded the space existing between the crown of a tooth and the gum, at the time of eruption, to reach to the cemento-enamel junction. Gottlieb, however, was able to show that this conception was misleading. In carefully prepared specimens of partially erupted teeth, he was able to demonstrate that Nasmyth's membrane is solidly united to the gingival trough. The gingival trough of the erupting tooth rarely reaches beyond one millimeter in depth and only gradually, with the outward movement of the tooth, does this trough retract toward the neck.
>
> There is never a break in the epithelium during the passage of the tooth from its crypt into the mouth and, consequently, never an exposure of connective tissue.

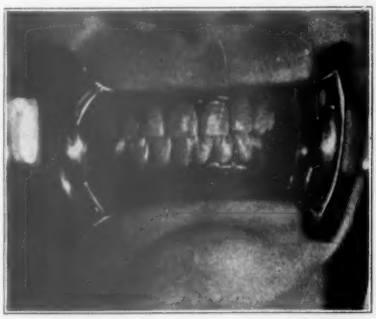

Fig. 1.—Porcelain jacket crowns on all anterior teeth. There is extensive gingival irritation.

The following quotation is from Gottlieb:

> In all studies of pathology, we must start from the normal. All studies about periodontoclasia are, in the main, studies about the pathology of the pocket. Until 1920, we all thought that the bottom of the normal pocket was at the cemento-enamel junction. Even in the first contribution to the histology of periodontoclasia by Fleischmann and me, this theory was used as a basis. Soon thereafter, I determined, from well prepared specimens, that we were all wrong about what constitutes normal pockets. . . .

Before the eruption of the tooth, the outer layer of the enamel epithelium is attached to the enamel surface and the two are grown together. There is no space between the epithelium and the enamel surface. Before the enamel is visible, the epithelium of the mouth and the outer layer of the enamel epithelium grow together, and, through an opening at the point of union, the enamel comes into the mouth. Next, the epithelium detaches itself from the enamel surface gradually as the tooth erupts. When the tooth reaches a position where it is in occlusion with opposing teeth, we speak of eruption as completed. We previously believed that the bottom of the pocket was now at the cemento-enamel junction. But not so: The detachment of the epithelium from the enamel surface has never, at this period, reached that point. Only about two-thirds of the crown has really come through the gum. The last third is still one with the epithelium, and the saliva, for instance, or food, or micro-organisms cannot reach this part of the enamel surface. This part is really not yet erupted. In the years following, the detachment goes on. . . . Before the bottom of the pocket reaches the cemento-enamel junction, a proliferation of the epithelium along the cementum begins so that the epithelium is always, to a certain extent, attached to the tooth surface, enamel or cementum.

As stated before, Gottlieb demonstrated that "in a young tooth, the bottom of the gingival crevice is not located, as was formerly believed, at the cemento-enamel junction, but upon the surface of the crown, and that the cervical part of the enamel and the enamel epithelium are still in organic junction." Gottlieb called the band of epithelium that is in organic connection with the tooth surface the "epithelial attachment."

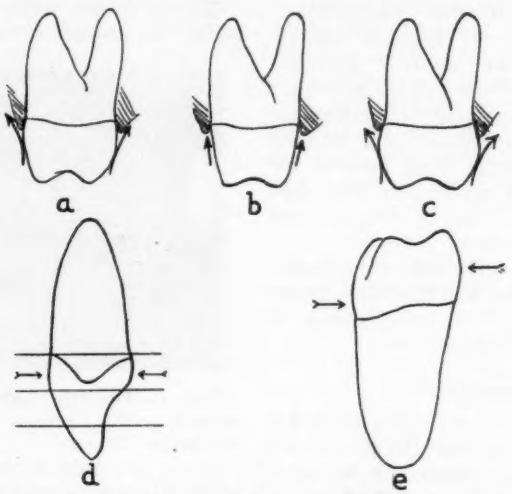

Fig. 2.—a, normal curvature. b, less curvature than normal. c, greater curvature than normal. d, point at which curvature is studied, cervical third. e, crests of curvature, mandibular posterior teeth.

Old Conception.—The epithelium is attached to the tooth in a line around the cemento-enamel junction.

New Conception.—The epithelium is not attached in a line, but in a band. This band of epithelium surrounding the tooth is united with the crown surface.

Regardless of the level of the surrounding tissues at different stages during life, the epithelial attachment is always

in evidence beyond the greatest depth of the gingival crevice.

I would advise all who are interested in the subject of histology of gingival tissues to read Dr. Kronfeld's latest book "Dental Histology and Comparative Dental Anatomy." In it he explains with clear illustrations just what the conditions are and how some of our misconceptions originated. Others who hold these views and accept the findings of Gottlieb are Orban, Maximow and Bloom, Skillen and Mueller.

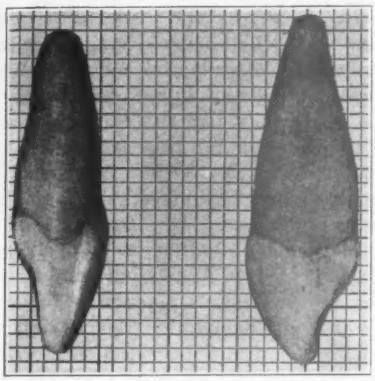

Fig. 3.—Maxillary central incisor and cuspid; method of superposing photograph of teeth on millimeter squares; illustrating outline of each tooth as accurate graph.

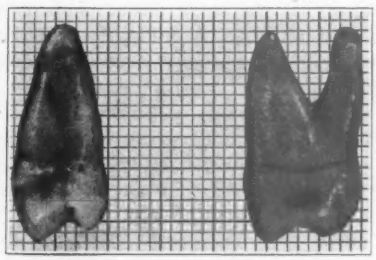

Fig. 4.—Maxillary first bicuspid and first molar.

What is the significance of all this to us as operators in restorative work? This: We are interested clinically in keeping the investing tissues about the teeth in a normal, healthy state. Therefore, it is most important that the epithelial attachment be kept intact, regardless of its level in the case at hand.

In order to avoid chronic hyperemia around the finished work, injury to the tissues must be avoided during operative procedure. Later, I shall show some adaptations in technical steps in jacket crown work which will help safeguard the epithelial attachment.

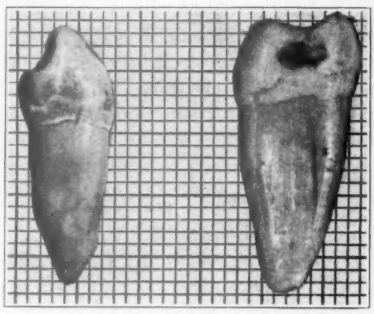

Fig. 5.—Mandibular first bicuspid and first molar.

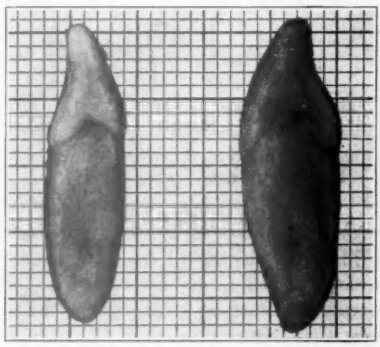

Fig. 6.—Mandibular central incisor and cuspid. A slight curvature at the cervical third is evident in comparison with Figures 2-4.

The next most important aspect of a fundamental nature in clinical work is the tooth form found at the cervical third of the crown in human teeth. This

includes, of course, the epithelial attachment levels mesial and distal, anteroposteriorly.

CONTOUR AT CERVICAL THIRD IN HUMAN TEETH, LABIAL OR BUCCAL AND LINGUAL

In contemplating restoration of tooth form, one finds it difficult to decide which portion of the form requires the most care in preparation and rebuilding. I think it will be conceded that permanency depends on normal function of the supporting structures around the teeth and that anything which would tend to affect this function unfavorably would shorten the life of the tooth or teeth in question. In view of this concession, the contours of the tooth crowns at the cervical third will be recognized as having considerable importance. The curvatures must be treated with respect since they have physiologic significance.

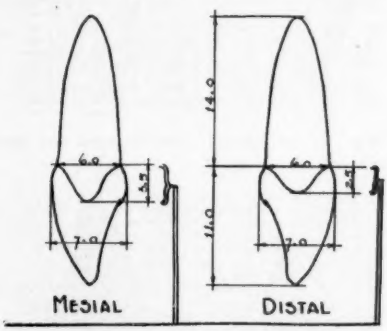

Fig. 7.—Curvature of cemento-enamel junction, mesial and distal.

Apparently, the curvatures function by holding the gingiva under a definite tension and also by causing food to be propelled over this curvature, preventing undue frictional irritation, which would drive the gingiva apically, resulting in recession of the gum tissue and consequent loss of the epithelial attachment. (Fig. 2b.) Normal curvature will allow enough frictional stimulation, however, for necessary tissue massage. (Fig. 2a.)

If the curvature is too great, another complication arises: The gingiva is protected too much and loses tone. Food material and the débris of the mouth will pack around the crevices of the crowns under this exaggerated contour and a veritable "back-water" will result, with stagnation of foreign material and chronic inflammation of the gingiva. (Fig. 2c.)

An attempt will be made to describe what seems to be the average cervical contour, labial or buccal and lingual, in each group of teeth in both the maxillary and the mandibular arches. This phase of the form has not been emphasized in the literature, and yet it is very valuable in preserving the gingival line and the investing tissues. The contour under consideration is that convexity or curvature occurring in all tooth crowns, above the cemento-enamel junction labially or buccally and lingually on the crown, and usually found at the cervical third when the teeth are viewed from the mesial or distal aspect. (Fig. 2d.)

The curvatures above the enamel margin on the teeth seem to describe a fairly constant arc in each locality in the mouth performing the same duties; i.e., mandibular anterior, mandibular posterior, maxillary anterior and maxillary posterior teeth.

In describing any features of anatomic form, it must be understood that there are always variations and no definite rule can be laid down. All that can be expected is that we may strike what seems to be a norm or an average. Variations from the norm are then better understood, and restorations are made accordingly. Cervical contours are no exception. If curvatures in any given case are found to be greater or less than the normal, the curvature, it has been my observation, will be uniformly greater or less, as the case may be, throughout the mouth.

Since there are variations; since it is extremely difficult to know when all the curvature is eliminated during a restora-

tive technic, and since it is most difficult, if not impossible, to restore the curvature when it is beneath the gingiva in young persons, the curvature should be allowed to remain intact whenever practicable. This does not pertain, of course, to most older patients, in whom the cemento-enamel junction is visible.

Fairly uniform cervical contours will be noted on all the maxillary teeth on both sides of the jaw and on the buccal portions of lower posterior teeth. (Figs. 3-5.)

Teeth when photographed natural size are rather small, and since engineer's graph paper divided into square millimeters is very confusing because of the smallness of the squares, it was decided to photograph natural teeth two times actual size, a procedure which squared the dimensions, and place cut-out photographs of those enlargements on a background of square millimeter graph paper. This seemed to afford a more accurate method than an attempt to superimpose a photograph on the background photographically. Therefore, the illustrations are in correct and scientific proportion, demonstrating measurements of the curvatures in millimeters or fractions of millimeters, the outline of the tooth appearing as a graph on the squared background. It will be noted that the normal curvature from the cemento-enamel junction to the crest of convexity is approximately 0.5 mm. This is the average or norm for the maxillary teeth labially or buccally and lingually and the buccal contour at the cervix of the mandibular posterior teeth. The illustration shows the central incisor and cuspid as having curvatures almost identical, exploding the popular view that the cuspid has greater convexity, especially lingually to the cingulum. The upper bicuspid and molar show the same limited curvature.

Even when greater curvature than these is noted, rarely is it as much as 1 mm., except at the lingual portion of the lower posterior teeth and occasionally at the lingual portion of the upper posterior teeth, and then the crest of convexity

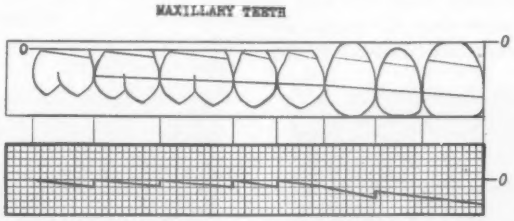

Fig. 8.—Diagrammatic drawing with graph of relative curvatures mesial and distal representing periodontal attachment.

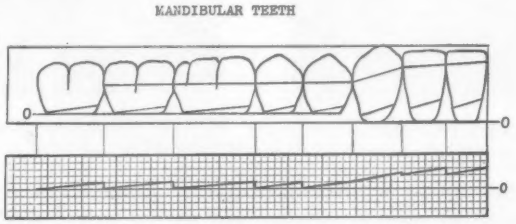

Fig. 9.—Diagrammatic drawing with graph of relative curvatures mesial and distal representing periodontal attachment.

is higher toward the occlusal surfaces, as previously described. It is only natural that the curvatures should be uniform since they have the same function at their respective positions. The eye is easily confused at times when viewing certain aspects of the teeth because of the abrupt sweep of curve as it travels from the cervical third to the incisal or occlusal surfaces; i.e., buccally in mandibular posterior teeth, lingually in maxillary posterior teeth and at the labial surface of cuspids. When the actual photographs are placed on a squared background with the long axis of each tooth vertical, it can be readily seen that the curvature from above the cemento-enamel junction

Fig. 10.—Mark made with stone cut at gingival crest before operating.

to the crest of the curve is less than was previously supposed. Usually, in restorative procedures, it is greatly exaggerated when it is reproduced.

Figure 6 illustrates a lower central incisor and a lower cuspid. Here, the curvature is less than in the other teeth, sometimes becoming so slight that it is hardly distinguishable. The cuspid has the same design at the cervical third in this respect as the mandibular central and lateral incisors; a fact which is often overlooked.

SUMMARY ON THE CONTOURS AT THE CERVIÇAL THIRD

All the maxillary teeth have similar curvatures, approximately the same labially or buccally and lingually.

Mandibular posterior teeth have the same cervical curvature buccally as the maxillary teeth, but differ in design on the lingual surfaces, showing the crest of curvature about half way between the cemento-enamel junction and the tip of the cusp, instead of at the cervical third. Mandibular anterior teeth differ in that they have less curvature on each side.

COMPARISON OF EPITHELIAL ATTACHMENT LEVELS ANTEROPOSTERIORLY

The height of normal gingival tissue between the teeth, that is, mesially and

Fig. 11.—Measurement of depth of gingival crevice before operating.

distally of each tooth, is directly dependent on the height of the epithelial attachment. Normal attachment follows the curvature of the cemento-enamel junction if the teeth are in normal alinement and contact; therefore, a comparison of the curvatures of the cemento-enamel junction mesially and distally will tell us what we wish to know.

The points at which curvature is measured are shown in Figure 7.

The extent of curvature seems to depend on the height of the contact point above the crown cervix and also on the diameter of the crown, labiolingually or buccolingually. In using the word "height" or "above," the supposition is

that, in either the upper or lower arch, the working surfaces of the teeth are "above" the cervices. Any point approaching the incisal edge or occlusal surface of a crown, therefore, is above the cervix and increases in height as it approaches the working surface.

The periodontal membrane seems to be attached just about as high on the lower teeth as on the upper. Although the lower anterior teeth average 1 mm. or less in labiolingual diameter (with the exception of the lateral incisors), the contact points are higher accordingly, being almost at the incisal edges. Consequently, calibrations will show less than

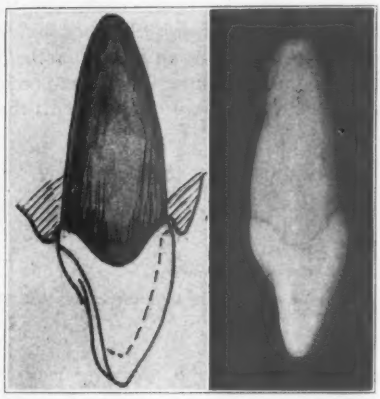

Fig. 12.—Relative positions of the shoulders on labial and lingual surfaces of the anterior tooth.

1 mm. of variation between maxillary and mandibular anterior teeth. There is no variation in the posterior teeth.

Figures 8 and 9 show outline drawings of the teeth of one side of the arch when viewed from the labial and buccal aspects. These outlines have been placed diagrammatically so that a direct comparison can be made with the graphs below them. The graphs demonstrate the relative height of individual attachments in the average normal case. They are based on cases having upper central incisors with crowns of from 10.5 to 11 mm. cervico-incisal diameter. Unless the teeth were very large or very small, the graphs would not vary from those illustrated by more than 0.5 mm.

The curvature of the cemento-enamel junction will be about 1 mm. less on the distal side of a tooth than on the mesial. This observation usually runs true, although no uncompromising line can be drawn in comparing any anatomic dimensions. If the upper central incisor, therefore, has a 3.5 mm. curvature mesially, the distal portion will have about a 2.5 mm. curvature.

In order to secure scientific data regarding comparative curvatures, it was necessary to obtain groups of tooth specimens from individual patients. It was

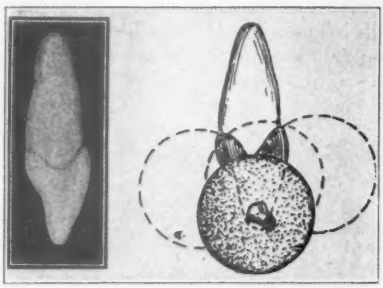

Fig. 13.—Placing carborundum disk in such way as to avoid damage to attachment.

discovered that usually a graph of the curvatures from the median line distally would be staggered as in Figures 8 and 9.

TECHNIC TO BE OBSERVED IN JACKET CROWN RESTORATION IN ORDER TO AVOID INJURY TO GINGIVAL TISSUE

The tissues about the tooth to be prepared are examined and the condition of the gingival tissues and the level of the gingival crest are noted. With a knife-edge mounted stone, the enamel of the tooth is marked on the labial surface of the crown at the level of the gingival crest. (Fig. 10.) With a gage made by tapering a celluloid millimeter rule, the

gingival crevice is probed and its depth noted. (Fig. 11.) If the crevice is 1 mm. or more deep (which it usually is), we are ready for the next step.

I might say here that, in my technic, I am interested in having the shoulder margin of the jacket crown extend under the normal gingival crest 1 mm. only and that on the labial or the buccal side. Esthetics demands that the shoulder margin shall not show on the finished crown. If it is at the level or above the length of the gingival crest on the lingual side, it does no harm, because that portion of the margin will not be seen, and leaving the margin at or above the gum line facilitates impression taking and all manipulative procedures in the technic. (Fig. 12.) Except in very short teeth, the retention will be sufficient. This eliminates a substantial portion of the shoulder margin as a possible source of irritation. It will be found that the epithelial attachment is usually higher on the lingual side and the cervical curvature is well covered by the gingiva.

The preparation of the tooth for the crown is not completed in one sitting. The reason for this will be shown presently. Part of the plan is to avoid the use of a local anesthetic during the first visit, because the preparation is not to be finished until the following day, when anesthesia will be needed. It is not advisable to make an injection in the same area unless more time is allowed to intervene. As much enamel as possible is removed, the preparation tapering toward the incisal surface, and removing 1 mm. or slightly more of the incisal tissue in order to free the occlusion. With the stones under a continuous stream of warm water, this can be done painlessly and in a comparatively short time.

The operator must remember the extreme curvature of the epithelial attachment on the mesial and distal surfaces of anterior teeth. Figure 13 shows how easy it is to strip the attachment while using a separating disk. Figure 14 demonstrates the final result of such carelessness.

After this phase of the preparation is finished, the tapered preparation is covered with a temporary crown made of gutta-percha. A small ball of gutta-percha is pressed over the tooth with the fingers until the gingiva blanches slightly on the labial surface, an indication that it is under gentle pressure. The gutta-percha is so shaped with plastic instruments that it will be free of the opposing teeth in occlusion and also the labial and lingual surfaces will be smooth. (Fig. 15.)

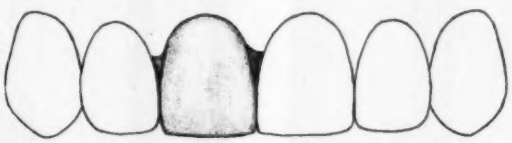

Fig. 14.—Loss of gingival papillae on each side of jacket crown due to unnecessary trauma during preparation of tooth.

The patient must be seen on the following day. At this subsequent visit, when the gutta-percha crown is removed, the gingiva will be seen at a new level, 1 mm. or more apically to the level where it was the day before. Under local anesthesia, the typical jacket crown preparation is finished with a well-outlined shoulder placed exactly at the level of the new temporary gum margin.

At no time will it be necessary to put burs, stones or files in the gingival crevice and thereby endanger the epithelial attachment.

Extreme care must be observed at this point in fitting and festooning bands for

impressions of the prepared tooth. The two-band technic is used. The bands must fit the prepared tooth tightly in order to assure a sharp shoulder outline. It can be readily seen that if the bands are forced over the shoulder very far when they are tightly fitted, the attachment will be injured. If the bands do not fit tightly, the impression of the outside angle of the shoulder will be faulty and rounded. The finished crown will have an open margin, causing irritation to the gingiva at some future time when the cement disintegrates. Therefore, I repeat that the fitting must be carefully and deftly done.

I use brass bands for this work, because they can be stretched with a band stretcher. A band that will fit the body of the preparation loosely is selected. It must not be large enough to encompass the shoulder until it is carefully stretched to dimension after the band is festooned to the shoulder outline. The band is kept parallel to the long axis of the tooth. As soon as the band slips gently over the shoulder, a sharp-pointed instrument is used to mark the band at the gingival crest. If the markings on the band show that it is passing the gingival crest evenly all around and no more than 0.5 mm. below the new gingival crest, the labial surface is marked for identification and a shorter band is fitted in the same manner.

Fig. 15.—Gutta-percha crown placed over prepared tooth.

Impressions are taken with modeling compound in the bands, the operator taking care to see that the bands do not go farther beyond the gingival crest than the level previously marked. The longest band impression is used to make the preparation model, and the short one is left on the prepared tooth in taking a plaster impression of the adjoining teeth, which serves to locate the preparation model accurately in a plaster cast of the mouth. With the impressions out of the way, the prepared tooth is varnished with a thin solution of resin and chloroform and the tooth is covered once more with a gutta-percha crown. This time, the temporary crown is cemented on with one of the balsam cements. If these precautions are observed, the tooth will be much less sensitive when the gutta-percha is removed.

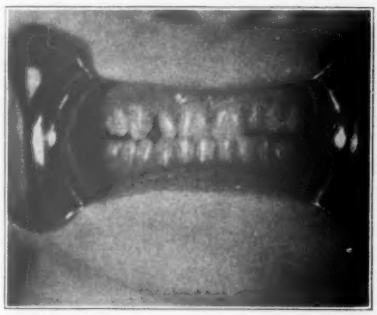

Fig. 16.—Dwarfed lateral incisors before restoration with porcelain jacket crowns.

The patient is now dismissed and told to return within forty-eight hours or less time. It is very important that the crown be finished and set within four days. Three days is preferable. I endeavor to arrange appointments so that any one jacket crown may be finished within three days. My reasons for this are these: I do not want the gingiva to be held under tension any longer than three days, because the new gingival crest level may be made permanent. I insist on a

gutta-percha pack, and patients are usually unwilling to be disfigured any longer than that, most porcelain jacket crowns being for anterior teeth. If the gutta-percha pack remains on the tooth too long, the shoulder margin of the finished crown will show, and thus the esthetic effect of the finished crown is spoiled.

A banded temporary crown or a celluloid form with silicate cement should never be used as a covering for the prepared tooth. These substitutes are likely to be very irritating and probably account for a great many instances of chronic inflammation around porcelain jacket crowns.

A word or two about the preparation

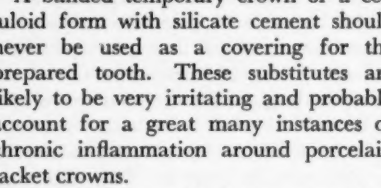

Fig. 17.—Case shown in Figure 16 with jacket crowns in position. There is no gingival irritation.

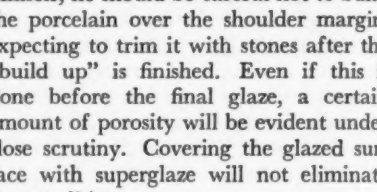

Fig. 18.—Porcelain jacket crowns on all anterior teeth except right maxillary incisor. There is no gingival irritation.

model: Naturally, a smooth model with a sharp, well-defined shoulder margin is required. It is difficult enough to adapt platinum foil to a smooth regular shoulder margin, and close adaptation of the finished crown should not be expected on a prepared tooth or model that is irregular in outline or on a model with a rounded shoulder.

I am getting better results with "Die-stone" for models of the prepared tooth than with any other material, and silver amalgam is my second choice. I have never been able to use copper amalgam successfully for this purpose.

The next precaution to be observed is in the porcelain adaptation at the shoulder of the preparation and in the glazing at this point during laboratory procedure. Unless porcelain is properly condensed and glazed, it is more irritating to gum tissue than any other material used.

If the dentist does the laboratory work himself, he should be careful not to build the porcelain over the shoulder margin, expecting to trim it with stones after the "build up" is finished. Even if this is done before the final glaze, a certain amount of porosity will be evident under close scrutiny. Covering the glazed surface with superglaze will not eliminate the condition.

During the porcelain adaptation, the material should be held at the margin from the beginning in order to insure a dense glazed surface on the finished crown at the shoulder. It must be remembered that this is the portion of porcelain which is to rest within the gingival crevice. If we do not do the laboratory work ourselves, we should be sure to warn the technician regarding these difficulties.

A warning at this point: Do not create a "double curvature" on the labial or lingual side at the cervical third of the crown.

Quite often, we leave the enamel curva-

ture under the gum line, and, as mentioned before, this is good practice if the epithelial attachment is high enough. We should keep this in mind when building up the jacket crown in the laboratory. Since we were formerly taught to remove all enamel above the cemento-enamel junction, we sometimes become confused and take for granted that our shoulder on the preparation model is at that point whether it is or not. The preparation model will not tell us anything: we must make these observations in the mouth.

Usually, curvature is built into the crown above the shoulder margin, and if it is one of those cases in which the natural curvature was left intact and another curve is put in the crown above the shoulder line, we shall have a double curvature, which will contribute to chronic irritation later. Naturally, the depression left between the two curvatures will be a favorable point of attachment for bacterial plaques and food débris, chemical and bacterial irritation resulting after the crown is placed.

There are two other precautions to be observed in jacket crown technic to safeguard gingival tissues. We must be careful, in seating the finished crown, to use the proper cementing material.

Porcelain jacket crowns are usually built with a slight plus contact mesially and distally. This, of course, is desirable, but the operator must remember this in seating the crown before final cementation. Contact areas must be judiciously trimmed in order to seat the jacket definitely at the shoulder margin and conserve a proper contact tension at the same time. Sometimes, a plus contact on one side will tip the crown so that the margin is left open at some place. It is very easy to do this. If the crown is cemented in that position, the cement material will wash out ultimately at the open margin and trouble result.

If the technic of preparation, impression taking and porcelain adaptation has been carefully observed, there will be no overhanging margins on the finished crown. We all know, of course, that such a thing would result in failure.

The last important phase in this work is the choice of cementing material. I have had little or no success with silicate and zinc oxide combinations. As silicate cements are always irritating when in contact with gum tissue, I do not believe in using silicate in cement that is to be used for cementing porcelain jacket crowns when all or part of the crown margin is within the gingival crevice.

I use zinc oxide cements, mixing them carefully and having all the shades or colors available, and although it is not easy to match the color of adjoining teeth when setting a porcelain crown with this material, it is all we have that is safe to use.

At the beginning, I displayed one of my worst failures. Now in justice to myself, I shall present two illustrations of successful cases. I derive a great deal more satisfaction from this work now than I did formerly, although I do not say that my cases now are successful in every instance.

The first case is one in which dwarfed lateral incisors were restored with porcelain jacket crowns, with adjoining teeth entirely free of dental restoration. (Figs. 16 and 17.)

The second case is one in which all the anterior teeth, upper and lower, were restored with jacket crowns except for the upper right lateral incisor. (Fig. 18.) The right cuspid is a bridge pontic. This case is the one used earlier to demonstrate the marking of the gingival crest before operating.

In conclusion, I wish to emphasize these points: The porcelain jacket crown can be the ultimate in dental restoration. Because the technic is difficult, failure is common. Although the technic is highly scientific, a good final result is art at its best.

Things truly artistic always require the proper background to bring out their excellence. The porcelain jacket crown is no exception to this rule. Its true background is the coral pink of normal gingival tissue. The purple of passive hyperemia will present a jarring note.

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TUMORS OF THE MOUTH

By CARROLL W. STUART, D.D.S., B.S., M.S., M.D., Chicago, Ill.

HEALTH campaigns are being conducted in this country as well as the other countries of the world for the control of some of the dread diseases of mankind. Two of these diseases, cancer and syphilis, are closely related to dentistry because definite lesions of these diseases are seen in the mouth. In the campaigns for the control of cancer and for the prevention of syphilis, dentists can and are taking an active part; and because they are now looking on all tumors of the oral cavity with suspicion, many patients are being saved from a terrible death. In consideration of the active cooperation of the medical and the dental profession at the present time, and the ever-growing tendency toward even closer united efforts, there is no reason that deaths from cancer of the mouth cannot be greatly reduced in number within the next five years.

Tumors of the oral cavity, like other pathologic conditions of the mouth, are due to changes in the chemical constituents of the tissues, abnormal function and irritation, bacteriologic, chemical and mechanical. Undoubtedly, there is a combination of these factors in many oral diseases, and the longer the abnormal process remains, the more likely the development of malignant tumors with their destructive processes, and their fatal outcome. The most satisfactory treatment for any disease of the human body, general or local, is prevention and, by virtue of this fact, the proper method of treating infections, benign tumors or cancers of the mouth is not to let them get started in the first place.

Tumors of the mouth do not grow overnight. Tissues must be prepared for the development of such a growth before enlargement really starts. For ex-

Read before the Section on Oral Surgery, Radiology and Anesthesia at the Seventy-Fourth Annual Midwinter Meeting of the Chicago Dental Society, February 16, 1938.

ample, a man, aged 50, has a broken down lower first molar tooth. Every time he swallows, his tongue rubs against the sharp fragment of tooth, until a small wound occurs. The pain is rather severe at first, but soon subsides, and there is no discomfort for several weeks. The wound remains and becomes infected, but the entire process is so slow that the patient does not become alarmed about it. All of the time, however, Nature has been forced to combat the local infection with all of her bactericidal power. In order to protect the underlying tissues, the cells in the immediate area have been called on to multiply. In fact, they have not had time to mature before they are called on to multiply again. The piled up fibrous tissue becomes covered with epithelial cells, and a papilloma is formed. The irritation continues, and between the jabbing of the tooth and the attempt of the cells to protect the tissues from this irritation, a very abnormal arrangement of cells results in which the epithelium dips down between the fibrous cells, there is rapid cell multiplication, followed by a change in the chemical reactions of the part, and a cancer is on the rampage.

Certain types of tumors seem to have a predilection for special areas of the mouth. Undoubtedly, one of the most common tumors of the lower lip is the retention cyst, or so-called, "mucous cyst." Of course, these do occur in other portions of the mouth, but they are to be found most frequently on the lips or cheeks because of the mechanical factor of biting, which it often the cause of these lesions. Any trauma, infection or irritation which tends to occlude the duct of a gland will cause the retention cyst to develop. It is characterized by a definite swelling which is neither soft nor hard to the touch and contains the fluid which is secreted by the gland. Occasionally, a blood vessel is ruptured and bleeds into the cyst, this giving it the appearance of a hemangioma. Several operative procedures have been designed for remedying this condition, such as passing sutures through the wall and retaining them in position in an attempt to create a new duct, making a V-shaped flap in the wall of the cyst and suturing the tip under to form a permanent opening. The most satisfactory procedure, however, in these cases which are not infected or do not cover too large an area is to make an opening into the cyst and excise the gland substance which is involved.

These cysts must be differentiated from the angiomas and particularly the hemangiomas. Excision of the latter is definitely contraindicated because of the copious hemorrhage which results. I can assure you one will not again make the mistake of excising. The hemangioma seen on the lips or in the labial sulcus appears as a dark blue tumor when in single form. The cavernous hemangiomas vary in form and color (dark blue to light blue) according to their extent upon the surfaces or under the mucous membrane. They may extend quite a distance into the tissues.

The methods of treatment consist of injection of boiling hot water into the tumor mass; or they may be excised, if not too extensive, by the cautery or radio knife. This instrument cauterizes the vascular tissues during the excision of the tumor. In the larger growths, radon seeds may be used with success. A row of radon seeds are inserted in the tumor immediately inside the margin. The rays cause a thickening of the cell layer which lines the blood vessels, and after irradiation has occluded these vessel compartments, another row of radon seeds may be placed inside of the first. Although this is the safest method, it is the most prolonged type of treatment, often taking several years and requiring many operations to obtain the desired results.

The lymphangiomas occur primarily upon the tongue and appear as yellowish blue cystic-like tumors or in the form

of small yellowish dots. The treatment is much the same as for the hemangioma, when it is necessary to operate.

LEUKOPLAKIA

Leukoplakia occurs on the lips as well as in any other portion of the mouth. In fact, it may occur on any mucous membrane in the human body. Although it is not generally considered a tumor, the condition is an associated one, being a definite precancerous lesion, and should receive attention. Although leukoplakia has been recognized as a definite entity for many years, little is known of the etiology. It is now evident that there is more than one form of the disease. It has been considered as "smoker's patch," which obviously ascribes it to smoking, but every dentist has observed it in the mouths of people who have never smoked. Another theory connects the lesion with the oral manifestations of syphilis, but again it is found in the mouths of patients who are free from this constitutional ailment. Recent observations identify the condition with gastro-intestinal disturbances of a toxic character. It has been my privilege to see many of these cases and to study the constitutional factors thoroughly.

From the standpoint of the lesion itself, there are two definite types: the smooth and the wartlike, or fulminating. The latter is merely a severe form of the former, regardless of the etiology. The treatment for the fulminating type is excision with the knife or, better still, the cautery wire loop. Radium is used by some. Caustic chemicals are definitely contraindicated.

Radium has been used in the treatment of the smooth type, but the most recent therapeutic measure is the use of a solution of Epsom salt taken by mouth, which is proving very satisfactory. One dram of a saturated solution given one or two times daily is usually sufficient. We do observe, however, that leukoplakia of itself is nothing but a hardening of the surface epithelium. It must be remembered that the mucous membrane of the oral cavity serves as an organ of elimination for toxins and metallic salts in the body. Evidently, the toxins cause an irritation to these surface cells and they become hard, actually piling up in some cases before they are thrown off. The late Dr. Jaffe described a slightly different condition in patients who are infected with syphilis. It was his belief that in these cases leukoplakia was a result of a battle between the mucous epithelium and the spirochete organism. In the syphilitic, there is an attempt on the part of the body to throw off through the mucous membrane the bacteria which cause the disease, and, at the same time, the organisms try to keep from being eliminated, actually burrowing into the tissues. Because of this local irritation, the superficial cells become hardened, leukoplakia being the result. It is interesting to note that the magnesium sulfate treatment is by no means so successful in the syphilitic as in the nonsyphilitic.

This condition is, however, one of the outstanding precancerous diseases found in the mouth. It has been found that 31 per cent of cases develop into cancer. We are not sure that smoking causes the disease, but smoking evidently does aggravate the condition.

The lip is one of the most common sites of cancer, which occurs more often on the lower lip than on the upper, and is found more frequently in men than in women. Again, irritation of a mechanical and chemical character is assumed to be the causative factor. It was noted a few years ago that many fishermen along the New England coast suffered from cancer of the lower lip and an investigation was made to determine the cause. It was found that these fishermen lived quite similarly to men in other walks of life except when they mended their nets. They repaired their nets by sewing them

with rather large thread coated with a tar preparation, and during the process of mending, they held the threaded needle in the teeth and resting on the lower lip. It has been known for many years that tar preparations, when applied to human tissues, may cause the development of cancer, and it was undoubtedly this chemical irritation which caused cancer of the lip in fishermen.

Any irritation, particularly mechanical, may be a factor in cancer. A surgeon in this city reported a case of cancer of the lip in a man occupied in laying carpets. He held the tacks in his mouth and picked them out over the left side of his lower lip. The cancer was removed surgically and the patient recovered. He returned to work and resumed his habit of holding tacks in his mouth, but owing to the scar on the left side of his lower lip, he picked the tacks off the right side. Within two years, he was operated on again for a similar lesion, this time on the right side.

Perhaps the most common tumor of the gums is the fibrous growth which is known as the "epulis." The term refers to any tumor "on the gum," and at one time included all tumors from fibromas to sarcomas, but of late the term is used to refer to fibromatous growths containing giant cells. These are rather benign tumors which are firm, smooth and slightly deeper in color than the normal mucous membrane. They usually involve the gingiva of two teeth. It has been thought that these tumors arise from gum tissue, the peridental membrane or the periosteum, but Jaffe found them to be a fibrous type of tumor with strands extending into the substance of the bone. He writes: "It is often surprising how deep these fibrous strands penetrate. It is obvious that owing to extension into the alveolar process the adjoining teeth must occasionally be sacrificed before the strands may be destroyed."

FIBROMA

True fibroma of the mouth is thought to occur in two definite forms: soft and usually pedunculated, and hard, with the sessile base. From a clinical standpoint, these tumors may assume all sorts of gradations between the two. The soft fibroma may have between the fibrous cells a sort of serous fluid, whereas the truly fibrous fibroma is made up of a rather firm group of cells which are densely packed together. They may be supplied with very few blood vessels or may be so vascular as to simulate the hemangioma. They may be found on the gums, lips, cheeks, tongue or palate. The treatment for this type of tumor depends on the amount of the blood supply and the extent of the operation. Simple surgical removal is usually sufficient; but in those large vascular tumors, the use of the cautery knife may be advisable, to avoid hemorrhage. Another type of fibroma usually found in the tongue occurs under the mucosa and is, therefore, spoken of as the submucous fibroma. It has been known to grow to the size of an English walnut, but as a rule is much smaller. These growths cause discomfort from the mechanical irritation. Occasionally, they become eroded and infected, an ulcer resulting which resists all treatment except surgical removal.

LIPOMA

Lipomas may be found in any portion of the mouth. They are the most benign of the tumors and arise from the deeper adipose tissue, seeming to expand as they reach the surface. They may, however, be submucous or even submuscular in the tongue. Lipomas are found more frequently in the male and their area of predilection in the oral cavity is a moot question. Most of them are reported as occurring in the floor of the mouth or in the tongue. The diagnosis of these tumors when situated upon the surface is

relatively simple unless they are mixed with other types of tissue cells; but when they occur in the substance of the cheek immediately anterior to the masseter muscle in the anterior border of the parotid gland, much study is required before a positive diagnosis can be made.

Surgical removal is the treatment of choice, but when a positive diagnosis has been made, it may be well to excise with a cautery knife, and if there is any question of a portion of the capsule remaining, it should be cauterized with a ball point at low heat. The mixed tumors of this group are represented by the myxolipoma, the lipochondroma and the fibrolipoma.

PAPILLOMA

Papillomas may be single or multiple. The single type of these tumors occurs in the oral cavity on the gums, tongue, lips, uvula and the pillars of the fauces. They are merely the result of proliferation of the normal papillary structures of the mucous membrane of the mouth. This increase in growth involves the connective tissue as well as the epithelium. As long as the normal ratio of these two groups of cells remains, the tumor assumes the characteristics of the normal tissue, but when there is an overgrowth of the connective tissue with increased vascular elements, it grows rather large. These tumors occur in areas of chronic infection or scar tissue and around ulcers. Polyps are of this group of tumors.

The presence of multiple papilloma is known as papillomatosis. Of themselves, these lesions are benign, but when they start growing rapidly and ulceration takes place, cancer may develop. Papillomatosis occurs on the floor of the mouth and the tongue and warrants a very close examination for cancer. As a matter of fact, the malignant transition may occur in several places at the same time. There are several ways of handling these growths. They may be excised, but perhaps the better method is the use of the cautery wire loop or cautery knife. If cancer is suspected, even though a biopsy report may be negative, preoperative irradiation with the deep x-rays is advisable, followed by removal and then by very close postoperative examinations, because these areas are very treacherous.

All of these conditions except perhaps the lipoma carry a varying percentage of precancerous characteristics. Many other oral lesions, conditions too numerous to mention here, are potentially malignant.

As for the malignant tumors which occur in the mouth, it would be possible to present illustrations of cancers for several hours and not show all phases of the subject or all cancers in their typical forms. One dealing with this branch of oral surgery is frequently at a loss to diagnose a malignant tumor merely from its gross appearance, and it is not at all necessary to do so at the present time because the biopsy examination is far more accurate and gives most valuable additional information.

The question is so frequently asked concerning the practical method of treating cancers, whether by means of radium, x-rays or surgical measures, that I should like to express the views of one of my former professors, the late Dr. Jaffe. In a lecture only a few days before his death, he discussed the subject in a novel manner. He said: "Malignant tumors of the mouth or any other portion of the body vary in characteristics as to gross appearance, rate of growth, early ulceration, rapid or slow metastases, and also in regard to their sensitivity and resistance to both the x-rays and the radium rays."

In general, the tumors of the floor of the mouth and the tongue are ray sensitive, but those in the upper portion of the oral cavity are ray resistant. The clinicians and their associates are becoming more and more efficient in determining, by means of microscopic analysis, the reaction of these tumors to ray therapy.

These tumors may change in their reaction rather suddenly. A cancer may be grouped as of a certain grade of sensitivity today and in one or two months may change into a far more resistant type, all of which shows the need for treatment immediately after the diagnosis is made. This is illustrated in the adenoma of the palate, which, within a few days, may change into a multicystic tumor, and as these cystic areas become loaded with cancer cells, the cylindroma is formed. The size of the field involved, the age of the patient, the presence or absence of infection and the extent of changes in the blood stream of the patient determine the type of therapy to be prescribed.

Most of the tumors of the throat are ray sensitive and should be so treated; whereas those of the salivary glands are more resistant and frequently require both irradiation and surgical procedures.

One point rarely stressed is the follow-up examination of these patients. A most satisfactory result may attend the treatment of a primary tumor of the oral cavity, and yet the patient's life may be lost unless he returns for postoperative examination at frequent intervals. These observations are made with a view of noting whether the patient shows symptoms of the original disease and if there are suspicious occurrences such as recurrence, metastasis or extension late becoming evident. It seems impossible to educate all patients to submit to this postoperative examination and check-up. Once in a while, after full instructions have been given concerning reexamination, a patient will come in complaining of a little soreness or stiffness in the neck and will be quite surprised to find us concerned over this new phase. As a matter of fact, by that time, it may be just too late.

These patients invariably explain their delay by saying that there has been no soreness at the original site of the tumor. In all suspicious conditions, whether a cancer or not, a follow-up examination should be demanded.

Regardless of whether patients are treated by one specialist who has been trained in all branches of tumor therapy or by several specialists, they are entitled to these postoperative examinations and at frequent intervals. When a number of doctors handle one case, it should be thoroughly understood among them, and by the patient, who shall do the follow-up work and when a progress report shall be forwarded to the group. Only in this way can patients be insured proper care.

BLOOD DYSCRASIAS

Another group of diseases are known as blood dyscrasias. Of course, blood conditions are not growths, but if we are to consider the blood as a tissue and the cells of the blood as tissue cells, any disease which involves an increase of the cells and tends to destroy the life of the host must be considered a malignant disease whether it is a tumor or not. I shall discuss this group here also because, regardless of textbooks, the first sign of these conditions is bleeding of the gums, and therefore they are of great interest to the dentist

In leukemia, polycythemia and purpura, the first sign of the disease is bleeding of the gums, and all of these conditions are malignant. In the foremost cancer hospitals of the world, the treatment of these diseases has a definite place in the program of the institution, and in many there is a separate department for them.

LEUKEMIA

Textbooks tell us that there are two types of leukemia in the main. As a matter of fact, there are twelve different kinds. I shall describe only two of them here.

Myelogenous leukemia is supposed to be due to "a hyperplastic condition of the

leukoplastic tissues with the appearance of abnormal white cells in the peripheral blood." Now, what does that mean? Of course, it is just this in simple terms: an overgrowth of the tissues which form the white blood cells, and with this a collection of the immature white blood cells in the capillaries and arteries. This is all right as far as it goes, and although I do not presume to tell the authors how to write their books, I do believe they might say that it is a constitutional disease which, in addition to this analysis, "is associated with a tendency to bleeding gums or severe hemorrhage following the extraction of a tooth."

We find that the first symptoms to be recorded are those due to enlargement of the spleen; or those which result from anemia. And one is supposed to assume that that means languor, pallor, weakness, loss of weight, labored breathing, dizziness, heart consciousness and either constipation or diarrhea.

One of the first signs of the disease is usually bleeding of gums. There may appear to be a number of pockets around the teeth, but, on close examination, one will find that the gums around the crowns of the teeth are swollen, giving the appearance of pockets. There may or may not be tartar around the teeth, and after a thorough scaling, the patient will complain of bleeding as much as before the teeth were scaled. Anything that may be done will not allay the bleeding from the gums. The swelling of the gums around the crowns of the teeth continues until, at times, there seem to be no buccal surfaces of the teeth exposed. Then one may expect sloughing of the gums, and after that Vincent's infection. The spirillum and the fusiform organism are parasites and grow best on necrotic material. As these tissues become involved to such an extent that they form a good culture medium for the growth of these bacteria, a gradual advancing process of disintegration takes place, involving the entire body. The spleen and bone marrow are two of the organs which have to do with the manufacture of new blood, and when they are incapable of doing their work, they tend to increase in size in the attempt. That is not, however, the sole reason for their enlargement. Then and then alone will the patient note the symptoms which are the result of the enlargement of the spleen.

Now, in brief, what is leukemia? The two types which are most commonly seen are the lymphatic and the myelogenous. The etiology of the former is unknown. Males are affected twice as frequently as females. It is a disease usually occurring in the later years of life, and nothing seems to be known concerning its cause. There is an increase in the number of white blood cells in the circulation, and, in this type of case, the increase is in the lymphocytes. There is also an increase in the size of the lymphoid tissues of the body. The lymph glands are enlarged and so is the spleen. The patient becomes weak and notices what he describes as recurrent attacks of pyorrhea. They not infrequently come in for the extraction of all the teeth because of what they think is pyorrhea and also because of bleeding of the gums. As a matter of fact, the extraction of teeth often hastens the patient's death because he has no resistance to infection or protein shock, to say nothing of the reaction to surgical shock, and is unable to withstand the excessive bleeding which may result.

From a dental standpoint, myelogenous leukemia resembles lymphatic leukemia. Jaffe described a leukemic tissue which invades the pulp canals of teeth and causes an irritation resulting in severe pulpitis. He cautioned the dentist against extracting teeth in patients with a definite history of bleeding gums, particularly of those teeth which appear normal and are without decay. He also called attention to the aggravation of constitutional diseases when one or more teeth are extracted during the acute stages of these conditions.

The important points of polycythemia are few. This is a constitutional condition which is manifested by an increase in the number of red blood cells. It is, fortunately, rare, as it is a very difficult condition to handle. These patients may also have bleeding of the gums, but not so marked as in leukemia On close examination, however, one will see that the mucous membranes are engorged with blood.

Because of this and the associated edema, the tissues of the mouth are swollen. The mucosa is a dull red and often slightly brown. The extraction of the teeth is associated with severe hemorrhage, which seems to last for hours in spite of all that one may do to control it. Fortunately, bleeding really does these patients a great deal of good provided there is not a too great loss of blood. These cases cause great worry even though one has definite information as to the constitutional condition before operation.

PURPURA

The several types of purpura are all characterized by a marked tendency to bleeding. The thrombopenic type is known to develop hemorrhage into or from the mucous membranes of the mouth or any other membrane of the body without apparent cause. This is known as spontaneous hemorrhage.

You will see, therefore, that conditions do exist which result in severe hemorrhage without the necessity of a large blood vessel's being injured. These are such consistently fatal diseases that they are considered to be malignant diseases just as cancer is.

A few suggestions are offered for caring for patients with these conditions:

1. The finger should never be used as a cheek retractor to examine a patient's mouth until we are sure that severe infection is not present. (Many dentists and physicians have been infected with syphilis because of such carelessness.)

2. The operator must ascertain that the teeth to be extracted are not surrounded by cancer tissue. The chances of curing a patient suffering with cancer of the jaw after the teeth have been removed are greatly reduced.

3. If not sure of a diagnosis of a tumor found in the mouth, the operator should take a small piece of tissue from the tumor for microscopic examination. A large section is not at all necessary. Frequently, the surgical procedure required to excise a large piece of cancer tissue is as detrimental to the patient as unwarranted radical procedures.

4. A positive diagnosis should be made and malignant tumors be classified before treatment is instituted.

5. Puttering treatment of any tumor is worse than no treatment at all.

6. All questionable conditions of the mouth or any other portion of the body should be followed by frequent postoperative examination, at times over a period of years.

7. Generally speaking, in all tumors and chronic diseases of the mouth, the possible transition into cancer must be kept in mind.

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HEREDITY IN RELATION TO SIZE OF TEETH

By Walter Hyde, D.D.S., Minneapolis, Minn.

In spite of the fact that recent years have seen great advances in the science of genetics, particularly as regards our knowledge of the mechanism of heredity, comparatively little has been brought out that adds to what we know about human teeth and their supporting structures. A very large part of the experimental work has been done on the fruit fly, observing a great variey of characteristics, but, of course, not dental characteristics.

In a previous paper,[1] I discussed the distribution of the chromosomes and the genes as carriers of inheritable characteristics, coming to the conclusion that in dealing with teeth and jaws and their anomalies, we are compelled to regard heredity as an important factor, but we must take into consideration that when we carry our problems to the geneticist, he will answer us by saying: "We do have an impressive knowledge of heredity, but as regards teeth, that is your field." It is incumbent, therefore, on every orthodontist to do what he can to add to our knowledge of heredity and its effects.

Any discussion of heredity presupposes some knowledge of the mechanism by which it operates. The processes themselves are so interesting that they will bear a brief review here.

Every cell of every living plant or animal contains a constant number of self-perpetuating bodies called chromosomes, clearly visible under the microscope. Half of these are traceable to the father and half to the mother. This is a very secure generalization, resting on much evidence both cytologic and experimental.[2]

In ordinary cell division, each chromosome splits longitudinally, forming daughter cells, each receiving half of every parent chromosome. In this manner, the number of chromosomes in all somatic cells is kept constant.

When the genetic cells begin to divide, there is no splitting of the chromosomes. Instead, one member of each pair passes, apparently at random, into the new cell. Each will have, then, but half as many chromosomes as the normal number. When two such cells—one male and one female—unite to form a zygote or individual, the normal number for that species is restored and a new individual life is begun. The chromosomes occur in pairs and, at one stage of this type of cell division, the two members of the pair approach each other and lie in such intimate juxtaposition that it is entirely probable that there is an interchange of substance between them. Indeed, there is evidence that such interchange actually occurs.[3] This is a point of interest as we speculate about the admixture of dental characteristics in the clinical material with which we are confronted.

The chromosomes are not themselves the units of inheritance, but each is composed of many particles, called genes. (Fig. 1.) The genes are thought to be the units of inheritance, each gene or group of genes being concerned with some characteristic such as stature, eye color, size or other definite quality.

Read before the Section on Orthodontia at the Seventy-Fourth Annual Midwinter Meeting of the Chicago Dental Society, February 17, 1938.

The genes are thought to be arranged like beads on a string, but are always in a double arrangement like two strings of beads (Fig. 1), one from the father and one from the mother.

This double arrangement is of great importance. It is the key that explains many of the puzzles of heredity. The genes are in definite linear order and will always be found in the same position.

Each member of a pair of genes is concerned with the development of a certain characteristic. They may, however, operate in a somewhat diverse manner, which will determine whether the new individual will be of a maternal or a paternal type.

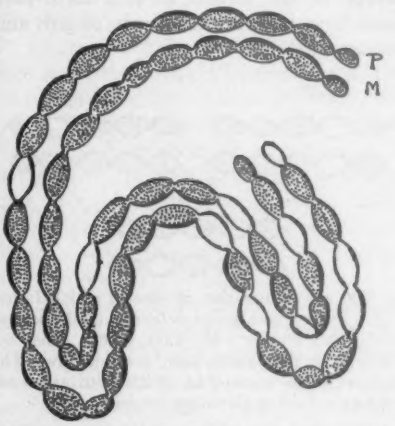

Fig. 1.—Arrangement of genes in genetic system. One string *(P)* comes from the father, the other *(M)* from the mother. Thus, the genes themselves are in pairs, one member of each pair from the father, one from the mother. The genes showing no mottling in the drawing are to be conceived as defective. (After Jennings.)

This may be illustrated thus: Figure 2 indicates a section of a chromosome and shows five pairs of genes. As shown here, the second pair from the mother are dominant over the second pair from the father. The child having the combination shown will therefore have a maternal characteristic.

Another method of forming new combinations of genes is in operation as the new generation appears. This is the recombination of grandparental genes in the offspring. Any individual as P or M (Fig. 3) has two sets of genes, one maternal and one paternal. When two such individuals mate to produce the next generation, each contributes one set of genes. It may be either the maternal or the paternal, but, in most instances, a recombination of the genes has occurred in the parent, resulting in the type of blending shown.[4]

Jennings says:

> No single individual of a later generation represents any single individual of a foregoing generation. For in the processes of reproduction, the materials of life, the genes, from many earlier generations, are thrown together, and from the mixture a new combination is extracted; so that each new individual represents or continues not one but many different individuals of foregoing generations.[5]

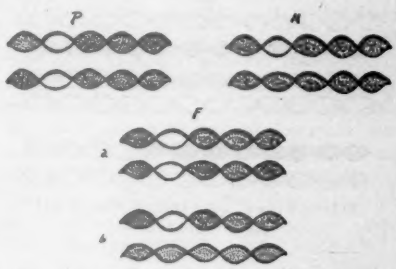

Fig. 2.—Illustration of case in which one parent *(P)* has two defective genes in one pair, the other *(M)* having one defective gene in same pair. Some of the children receive two defective genes in one pair and are therefore defective. Others with but one defective gene in that pair will not be defective.

In all the examples discussed, we have referred to the inheritance of like characteristics, which are of course most easily recognized. We must remember, however, that differences can be inherited also. (Fig. 4.)

There occurs one further step in the development of the teeth and jaws that

may contribute to this distribution of inherited characteristics. I refer to the fact that the teeth themselves and their supporting structures have their origin in separate embryologic layers. The teeth develop from the ectoblast and the alveolar bone and jaws from the mesoblast. We shall return to this point later.

That size in anatomic structures is markedly influenced by heredity is a well-recognized fact in genetics.[6] Any dentist who has made thoughtful observations will readily call to mind evidence of this from his practice. My own observations indicate that large teeth are sometimes inherited as a dominant characteristic.

Size, in teeth, presents great variation,

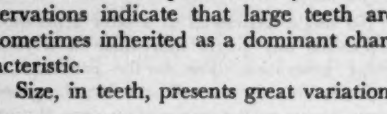

Fig. 3.—Recombination of grandparental genes in offspring.

showing that we are probably often observing a blend of inheritance rather than a simple dominant. Hrdlička[7] says, "According to all indications the normal heredity of the teeth and jaws is, aside from what is sex linked, a blend heredity as that of many other and particularly epidermal features of the body, and not the simple mendelian inheritance with its dominance, recessiveness and segregations."

In some individuals, we may find large upper central incisors and comparatively small lateral incisors. Another may have small bicuspid teeth with large anterior teeth; or one whose anterior teeth do not attract attention by their size may have excessively large posterior teeth. There is often presented a variation that amounts to a disharmony between the size of the upper teeth and that of the lower. All will recall numerous cases in which the upper anterior teeth are in excellent alinement, but with more or less overlapping and crowding of the lower teeth.

In some cases, there is a variation in size of the teeth on the right and left sides of the mouth.

Sex seems to have little to do with size in human teeth. It is by no means true, as formerly so often thought, that man's teeth are usually larger than woman's. Some of the largest teeth I have ever seen have been in the mouths of girls and women.

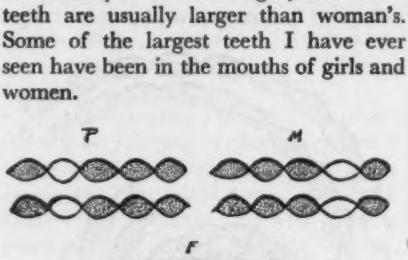

Fig. 4.—Illustration of case in which father *(P)*, having both genes defective in the second pair, and mother *(M)* having both genes defective in the fourth pair, are defective. The offspring has no pair in which both genes are defective and is therefore normal.

Size in teeth is interesting in other ways. For years, it has been routine procedure in my office to measure the mesiodistal width of the teeth of all my patients, when studying cases of malocclusion. In this manner, I learn exactly how much material requires arrangement, and it is useful information because there is a proportion between the combined width of the teeth and the necessary width of the jaw. Do not misunderstand me to say that I think human anatomy is mathematically exact. Variation is too frequent and too great. So much variation and disharmony exists, as previously suggested, that it makes me dis-

trustful of the ability of the human eye to judge the required width of the dental arch, as many men do in orthodontic therapy. I find the measurement and comparison of the existing size of the arch with the estimated supposed requirement very helpful.

Another observation, made over a period of more than twenty years, may be of interest to you. My practice is in Minnesota, with sufficient patients from the near-by sections that I have some acquaintance with an area several hundred miles in extent. I am certain that, in general, the children I now know have larger teeth than those I knew twenty years ago.

There is no question that young people are taller than were the members of the two preceding generations observed. We know from Mendel's experiments with tall and short peas that tallness is a dominant. Tallness is merely an excessive measure in the vertical plane. May not large teeth be a similar dominant more particularly expressed in width; i.e., the horizontal dimension?

I am aware of the limitations inherent in one man's observations and in the limitations of his clinical material. These observations may have no value whatever. On the other hand, they may sometimes tend to verify the observations of other workers and thus become of value.

My conclusions are based upon two observations. During the early years of my practice, the average requirement as to arch width (measuring from molar to molar at the point where the groove crosses the buccal ridge) was 57 mm., according to my calculations. Now, we are seldom able to arrange the teeth as desired in an arch of that size. Most patients require 59 mm. or more and 62 is not an uncommon figure.

In order to substantiate this opinion, I have looked up Black's measurements, using only those figures referring to mesiodistal width. For the sake of simplicity, I have taken the sizes of three upper teeth, as follows (Fig. 5.):

Central incisors:	Average	9.0 mm.
	Greatest	10.0 mm.
	Least	8.0 mm.
Lateral incisors:	Average	6.4 mm.
	Greatest	7.0 mm.
	Least	5.0 mm.
First molar:	Average	10.7 mm.
	Greatest	12.0 mm.
	Least	9.0 mm.

Knowing as we do the extreme care with which Dr. Black did all his work, we can feel sure that these are fair observations. He said, in regard to them:

> The numbers measured of the different varieties differed, but in all denominations they were sufficient to insure reasonable accuracy as to average size. There are three measurements given: the average, the greatest, the least. With a greater number, both larger and smaller teeth might be found, so that the tables must not be taken to represent the greatest nor the least that might be obtained, but the occurrence of larger teeth must be rare.[8]

Selecting at random from my own cases and making measurements to compare with Black's figures, I find that, in almost every instance, they are higher. Apparently, the average in my patients is almost equal to what he calls greatest, and in no instance have I found teeth so small as his smallest.

Conceded that my observations are correct or even partly right, why should this be? May it not be partly due to heredity and may not many of our orthodontic problems be traced to hereditary conditions plus the fact that the teeth and their supporting structures are developed from separate embryologic layers?

Mention has been made of this previously. In 1932, in a paper entitled "Limitations of Orthodontic Treatment," De Vries[9] wrote:

The more I read of and observe clinically cases of malocclusion, the more I am convinced that actual disharmonies do exist between teeth and bony structures. . . . If we are beginning to find ourselves in a frame of mind in which we are willing to admit the possible existence of such disharmonies, we are going to be forced into a train of thought which may well result in development of a real biologic background for orthodontia.

We are certain that heredity has much to do with the size of teeth. I believe that large teeth are frequently a dominant characteristic. Except in pathologic conditions, I know of no other factor in the size of teeth. Alveolar bone, on the other hand, may originally be influenced by hereditary factors, but we know of at least two environmental conditions

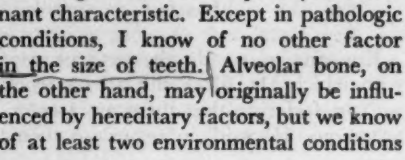

Fig. 5.—Black's measurements of mesiodistal width of three upper teeth.

that probably are very important. First is the stimulation brought about by the development of the teeth themselves and second the possible effect of function or the lack of function.

Orban[10] says:

The alveolar bone is formed by the connective tissue of the periodontal membrane as a result of the functional stimulus from the tooth. While the cementum is being deposited, the fibers of the periodontal membrane become embedded in it, and in this way transmit the force of the growing tooth to the surrounding bone. In consequence of this functional stimulus, the connective tissue approximating the bone begins to lay down alveolar bone. *Function in this case is not to be confused with the function of the tooth in mastication.* The functional stimulus of the growing tooth results from the movement of the developing tooth. Transmission of this functional force commences as soon as cementum begins to be deposited and connective tissue fibers become embedded in it. Around tooth germs which have no cementum, we observe a condensed area of bone known as the crypt of the follicle. This condensed bone is not true alveolar bone; it is not developed as a result of functional stimulus. This type of condensed bone surrounds every larger space in spongy bone. We can see it around normal sinuses, also surrounding cysts and granulomas.

As regards function, always when confronted with an orthodontic problem, we must consider the possible part played by mastication as a stimulus. And how rare is the patient who actually masticates vigorously!

One other stimulus may concern us; namely, that exerted by an orthodontic appliance. Suppose, however, that, in blended inheritance, the genes concerned with the development of the alveolar bone of the patient came from an ancestor having as a definite characteristic a small and poorly developed type of alveolar bone: are we not faced at the very start with a condition that may constitute a severe orthodontic limitation?

In the end, it all comes back to something like our earlier conclusions. The wise orthodontist will make himself familiar with the workings of heredity; he will be on the lookout for its manifestations, and he will keep records which include all that he can learn of the family as well as the patient's history.

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RELATION OF DIET TO ORAL HEALTH

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THE complex problem of diet in its relation to oral health will be considered from three angles: the relation of diet to the structure of oral tissues, the effect of structure on oral health and the integrity of the erupted tooth. The two prevailing concepts of the etiology of dental caries will be presented, with accumulated evidence for or against each. Is caries caused primarily by nutritional errors or metabolic disturbances that influence the tooth from within? Is the environment of the tooth in the mouth the controlling factor in the causation of this disease? If so, how does diet influence this environment?

PROBLEMS CONCERNED WITH THE STRUCTURE OF TEETH AND OF PARODONTAL TISSUES

No one today questions the belief that a nutritionally adequate diet is fundamental to the formation of sound teeth and parodontal tissues and to the development of jaw bones capable of providing room for the permanent teeth, thus making normal occlusion possible. The careful observations of Logan and Kronfeld and others,[1, 2] however, have clarified our ideas as to age periods for calcification of the crowns of our teeth. We now know that nutrition of the fetus is of great importance in the formation of sound deciduous teeth, but that it is on the postnatal diet of the infant and child that we must depend for help in the calcification of all of the permanent teeth and in the completion of the crowns of some of the deciduous teeth. Therefore, from birth until the crowns of the third permanent molars are fully formed, the diet should be as nearly adequate nutritionally as the economic circumstances of the individual permit.

Because of the similarity of composition of bone and tooth structure, attention has been centered on insuring normal calcium and phosphorus metabolism during infancy and childhood. The diet should contain adequate amounts of these minerals. As milk is the richest known source of food calcium and a dependable source of phosphorus, it is generally regarded as an essential in the diet of infants, children and adults. It is not enough, however, just to supply adequate amounts of these two minerals in the diet. Conditions must be such as to make possible their utilization within the body. Some illnesses make it impossible to con-

Read before the Section on Operative and Preventive Dentistry at the Seventy-Fourth Annual Midwinter Meeting of the Chicago Dental Society, February 16, 1938.

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sume milk in sufficient amount. Other acute or chronic conditions interfere with absorption of many of the nutritive constituents of food, including minerals. Because of a shortage of ultraviolet light in the rays of the sun reaching the areas of the earth's surface far removed from the equator, infants and young children living in such areas have to be given vitamin D orally to enable them to develop sound bones and teeth from their dietary supply of calcium and phosphorus. When vitamin D in some form is administered to them as a supplement to a suitable supply of these minerals, the results are as advantageous to good dentition as they are adequate for rickets prevention.[3-6] Horizontal bands of imperfect enamel are mute evidence of the approximate age at which interference with normal calcification of the enamel takes place.

Vitamin C has been found essential to the normal structure of the teeth of guinea-pigs.[7-9] However, because the teeth of this animal are constantly growing out and wearing off, they are not comparable to human teeth.

Wolbach and colleagues[10a] established the fact that deficiency of vitamin C results specifically in "failure of connective tissue cells to form collagen fibers and of odontoblasts and osteoblasts to form the collagenous matrices of dentin and bone." In another report, Wolbach[10b] says, "Calcium metabolism is not *primarily* affected. In advanced scurvy calcium salts are liberated through the resorption of bone matrix which is the process of the osteoporosis of scurvy." Enamel forming cells seem not to be affected. Hess and Abramson[5] report inability "to find clinical data in regard to the effect of infantile scurvy on the permanent teeth," and say also that infantile scurvy does not even delay the eruption of the teeth.

The most extensive observations on the effect of vitamin A deficiency on children have been reported by Bloch, in Denmark.[11] He studied the permanent teeth of forty-five children who had had xerophthalmia in early infancy and childhood uncomplicated by clinical symptoms of rickets. He concludes that "in man, deficiency of vitamin A has no specific injurious effect on the formation and calcification of the teeth." Other observations have been reported by Wolbach and colleagues.[10]

A high fluorine content of drinking water is known to produce mottling of the enamel of all of the permanent teeth and of those deciduous teeth the crowns of which are undergoing postnatal calcification. There seems to be no mottling of the enamel of those deciduous teeth the crowns of which are largely formed during the prenatal period.[12]

The next question is whether the structure of a tooth is subject to change after eruption. It is known that the ameloblasts, or enamel-forming cells, cease to function by the time a tooth is erupted. Dentin lies between the enamel and the pulp chamber, which contains the blood supply. It is known that, after eruption, a denser area of dentin may be deposited adjacent to the pulp chamber in an effort on the part of Nature to protect the tooth against injury or irritation on the surface of the tooth. A number of students of dental problems[4, 13, 14] believe that ability to form this layer of protective secondary dentin is continuously dependent on the nutritional factors that govern the original calcification of the tooth; namely, calcium, phosphorus and vitamin D.

Fish[15] recently reported inability to alter the total calcium content of the dentin of dog teeth by giving extra vitamin D and calcium for long periods of time.

At the recent meeting of the Federation of American Societies of Experimental Biology in Baltimore, Dr. Aub, of Harvard University Medical School, presented conclusive evidence* of the presence of radium in the dentin and bones

*Unpublished at time of going to press.

of patients afflicted with radium poisoning. None was present in the enamel. In some patients, this foreign substance was still present in the dentin and bones fifteen years after the last exposure to radium.

We thus know that radium and extra calcium salts may enter dentin after the tooth is erupted, presumably via the blood supply of the pulp chamber. However, there has been no equally conclusive evidence submitted that decalcification of dentin in teeth such as ours may take place. Dr. Aub made the statement in Baltimore that since radium could and did enter dentin, calcium salts could leave it. Radium is a highly reactive and toxic substance. The tendency of Nature is always to try to render toxins that enter the body harmless. It is possible that the dentin of teeth and the shafts of bones act as excellent places in which to store toxic radium. The presence of radium in dentin proves nothing as to possibilities for active decalcification of this stable structure.

Roentgenographic and histologic studies have been reported of the teeth of a few patients who have died of serious decalcification of the bones due to hyperparathyroidism. No changes in dentin were detected, except in teeth undergoing calcification during the disease.[16]

There is an old saying, "Every baby means the loss of a tooth," based on the prevailing belief that, unless the diet of the mother contains plenty of calcium, pregnancy and lactation cause demineralization and subsequent loss of one or more teeth, depending on the number of babies she has. In commenting on this adage, Schour[17] dismissed the subject by saying: "This warning implied a provident gift of nature to conserve at least in part the dental apparatus by sacrificing only one particular tooth at a time instead of depleting a little from every tooth." There is a dearth of evidence in support of the belief that pregnancy increases susceptibility to dental caries and some evidence to the contrary.[18]

Failure to use the teeth in chewing may, in time, cause an unhealthy condition of the parodontal tissues.[19] There is no doubt that, at any time of life, scurvy, while it lasts, is associated with edematous and hemorrhagic conditions of the gums and with active disintegration of the jaw bones and resultant loosening of the teeth.[10] Administration of vitamin C restores these conditions to normal. Any other condition which causes extensive decalcification of bones, such as repeated pregnancy and lactation periods on low calcium diets, or hyperfunctioning of the parathyroid glands, may cause softening of alveolar bone and loosening of the teeth. Whenever the attachment of teeth is impaired, whether from excessive tartar, bone resorption, scurvy or other conditions, formation of pus pockets is favored. No one doubts the resultant detriment to health. There is evidence that a subminimal intake of vitamin C may, in many persons, be responsible for gingivitis.[20]

What is the relation between soundness of the structure of teeth and dental health?

Mrs. Mellanby, in England, has reported[4] extensive observations on the prevalence of dental caries in extracted deciduous teeth of children. When she compared teeth showing defects in structure with those that seemed to be perfectly formed, she found five and one-half times as many hypoplastic teeth that were carious as well-enameled teeth. Other students of the etiology of dental caries question the primary relationship of defects in structure to caries.[21] Certainly caries-susceptible areas on teeth frequently do not correspond in location to hypoplastic areas.[22] Dentists have reported numbers of persons with markedly hypoplastic teeth that had no cavities. A number of observers have reported that children known to have had

severe rickets in infancy and early childhood were no more susceptible to caries of the permanent teeth than other children of similar age who had never had rickets, even though their teeth were much more hypoplastic.[5, 6, 8] Mottled teeth are known to be singularly free of caries. Many persons with seemingly no structural defects in their teeth are susceptible to tooth decay.[23]

Study of the cause of tooth decay in experimental animals has been difficult because it is hard to find small animals with a permanent tooth structure resembling ours and in which cavities could be produced experimentally. The molar teeth of rats do resemble our molars and experimental caries can be produced in them. However, restriction of rats to diets very deficient in minerals has not produced caries even in second generation animals, although the molars were markedly hypoplastic.[24]

IS THERE A DIRECT RELATIONSHIP BETWEEN NUTRITION AND METABOLIC PROCESSES AND CARIES SUSCEPTIBILITY?

In most of the civilized world, dental caries represents the commonest form of disintegration of erupted teeth. Much work has been done in an effort to solve the complex problem of what causes such a widespread disease. An effort will be made to evaluate the many seemingly conflicting theories as to the relation of nutrition and metabolism to this disease.

1. At the University of Iowa, Boyd represents a group believing[13, 25] that the nutritional completeness of diet is the best preventive and corrective for caries susceptibility and that any diet modification supplying a nutritive essential that has been previously neglected favors arrest of progress of the disease. As has been previously stated, every effort should be made to provide nutritionally adequate diets to children throughout the growth period, for the protection of the general health and to insure the formation of sound teeth and strong bones. Evidence, however, has been accumulating that such diets may not, merely because of their high nutritional value, be of equal value in the prevention of dental caries.[26, 27] It is possible that there is in the Boyd and Drain diets some other factor than unquestioned high nutritive value that more adequately explains their success in controlling caries. The other possible factors will be discussed later. Finally, some individuals whose customary diets are inadequate according to all accepted nutritional standards are known to have no tooth decay.

2. Other students of tooth decay believe that the secret of prevention centers in vitamin D. Mrs. Mellanby, after extensive studies of children living in public institutions, believes[4] vitamin D to be the most important preventive factor yet discovered, especially if given while the teeth are being formed. Others oppose Mrs. Mellanby's theory.[28] Day and Sedwick recently[29] gave daily doses of vitamins A and D for fourteen months to 147 Rochester school children of uniform age, while 171 others in the same age range served as negative controls. All lived in private homes. The observed increases in caries index was approximately the same in the two groups. Only one type of diet has, so far, been successful in causing caries in rat molars.[30] The cavities formed closely resemble human caries. Extra calcium, phosphorus or vitamin D, or combinations of these three supplements, when added to this caries-producing diet, has no effect in preventing cavities in the molar teeth.[24, 31-33] Later on, reference will be made to a group of institution children who are singularly free of caries,[26] but whose immunity to this disease could not be explained as due to optimum intakes of calcium, phosphorus or vitamin D, and whose diet was below accepted standards of nutritional adequacy. Civilized persons living in the tropics are as suscep-

tible to caries as are those living around us, even though amply supplied with vitamin D from the action of ultraviolet light on the skin.

3. If either the intake or the metabolism of calcium and phosphorus is related to caries susceptibility, it should be possible to find detectable differences in the calcium and phosphorus content of blood or saliva, or differences in ability to store these minerals in caries-free as compared with caries-active persons. What do we find?

Boyd, Drain and Stearns, at the University of Iowa, found[34] no correlation between the levels of calcium and phosphorus in blood and in saliva and the susceptibility of children to tooth decay. Their data, however, seem to support the belief that caries-susceptible children are less able to store calcium in their bodies than are those free of tooth decay.

The University of Michigan group has confirmed the foregoing findings as to lack of correlation between caries activity and the amounts of calcium and phosphorus found in the blood and the saliva of children.[27, 35, 36] They believe also, as a result of their extensive studies, that there is no relationship between the dietary supply of these minerals and the amount present in the two body fluids mentioned. As will be seen later, the University of Michigan group has succeeded in increasing or decreasing susceptibility to caries in a number of children by simply increasing or decreasing the sugar content of the diet, the calcium and phosphorus intakes remaining constant.[27] The amount of sugar in the diet made no significant difference, however, in the ability of the children to store these minerals.[37] These data seem to be at variance with the observations of Boyd and his colleagues, but there were fewer children studied by the Michigan group than by the Iowa group.

Mull and his colleagues, in Cleveland, reported[18] studies conducted on 358 pregnant women. They could find no difference between the level of blood calcium and phosphorus in the 15 per cent who developed cavities and in the 85 per cent that did not. Karshan, at Columbia University, agrees with the statement that there is no correlation between total salivary calcium and phosphorus and caries activity,[38, 39] but has presented evidence that the percentage of total salivary calcium removed by shaking saliva with tricalcium phosphate is in caries-free persons one and one-half times that in the caries susceptible.[38] This observation awaits confirmation in other laboratories. No attempt, as yet, has been made to explain the possible significance of such data.

It was to be expected that levels of calcium and phosphorus in blood would bear no relation to caries activity. Caries is a common disease of otherwise healthy persons. Significant variations from normal blood values are associated with clinical symptoms. Except in infancy, when the reserve supply in the bones is low, or in certain endocrine disorders or other conditions associated with marked decalcification of bones, the calcium and phosphorus content of the blood varies only within narrow limits because of the enormous labile reserve supply in the bones.

Several workers have recently published data[40, 41] showing differences in chemical composition of carious as compared with non-carious teeth. Such studies, however, can give no information as to whether these differences are the cause of dissolution of the tooth or are the effect of the carious process.

4. Others believe that the cause of dental caries centers in the acid neutralizing power of blood and of saliva. This property of body fluids may be expressed by a figure called its pH, which indicates the degree of acidity or alkalinity, and by a figure representing the ability of the fluid to combine with carbonic acid gas

or carbon dioxide. Some foods, when used up by the body, leave an acid ash. These foods are meats, fish, poultry, eggs, cheese, cereals and breads, sweet corn, peanuts and lentils. Other foods, when metabolized by the body, leave an alkaline ash. Foods in this class are all forms of milk, beans, vegetables, practically all fruits and most nuts. Still other foods, such as edible fats and oils, pure sugars and pure starches, leave no ash when metabolized and so are neutral in reaction ultimately. It has been demonstrated[42] that, under conditions of ordinary good health, the buffer value of the blood is so nicely adapted to its function that long-continued use of a diet that is definitely acid in reaction when metabolized cannot alter the remarkably uniform slight degree of alkalinity of the blood. The belief in the widespread prevalence of the so-called "acid system," so freely encouraged in many radio programs, is without foundation of fact. Life would not be possible if the blood were to become acid. Any significant lowering even of its degree of alkalinity and of its carbon dioxide combining power brings on acute clinical symptoms.

Jones and her colleagues, from observations in Hawaii, believe that it is the acid-ash nature of the native diet of large numbers of the population that determines the high incidence of odontoclasia,[43] or complete and rapid disintegration of the crowns of deciduous teeth, and that an acid-ash diet causes dental caries.[44] To date, however, they have submitted no data showing related effects of this acid-ash diet on the pH or carbon dioxide combining power of blood or saliva. If their theory is sound, some effect of this nature should be determinable, in contrast with that produced by an alkaline-ash diet.

Karshan recently reported[25] average carbon dioxide combining values of 31.1 cc. per hundred cubic centimeters of saliva for twenty-two caries-free persons and of 19.5 cc. for forty-one persons with apparently active caries. The age range of these subjects was 13 to 42 years and all lived in private homes. The patients were under observation for only one week and there were one to three determinations for each subject.

The Michigan group has reported[25] average carbon dioxide combining values of 31.0 cc. per hundred cubic centimeters of saliva for fifteen caries-free school children and of 21.6 cc. for seventeen school children with active caries. All of the children lived in private homes. The determinations were repeated many times on each child, always under uniform conditions, over a period of one and one-half years. Analysis of these data[45] shows a range in average values per individual of 20.1 to 45.9 for the caries-free group and of 8.3 to 50.9 for the susceptible. The child with the average value of 50.9 cc. of carbon dioxide per hundred cubic centimeters of saliva was very susceptible to caries. If this property of saliva has a specific protective value, why did it not protect this child's teeth? However, it is interesting that the group averages of Hubbell and Koehne so closely resemble those of Karshan. The carbon dioxide combining power of saliva may bear a relation to caries activity. The Michigan group was not able, however, to observe significant differences in this value for saliva in caries-free and caries-active subjects in two groups of children living in institutions.[26, 27] Neither was it able to find any relationship between the acid-base value of the diet of these children and the pH or carbon dioxide combining power of their saliva.

If the ability of saliva to neutralize acid does prove to bear a close relationship to caries activity, the explanation would seem to be in the ability of saliva to neutralize acids formed in protected areas on the surface of teeth.

Bodecker[46] believes, as a result of certain dye diffusion tests, that there is a

circulation of dental lymph throughout the tooth which has an alkaline reaction higher than that of blood. He claims that there is a mechanism within the tooth which concentrates the acid-neutralizing power of the blood for the protection of the tooth against acid that may be formed on the exterior surface. His theory is interesting, but its truth is difficult to prove. Beust[47] opposed this theory.

5. The reports of White of the Michigan group[48] and of Youngburg[49] fail to confirm the relationship between the ammonia content of saliva and caries susceptibility as reported by Grove and Grove.[50, 51]

IS THE PRIMARY CAUSE OF DENTAL CARIES ENVIRONMENTAL AND, IF SO, WHAT RÔLE DOES DIET PLAY?

A consideration of whether the primary cause of dental caries is environmental and, if so, what rôle the diet plays centers around the theory that the cavity is initiated on the outside of the tooth and its primary cause is found in the mouth. This theory postulates that the cavity is produced by acid elaborated by colonies of aciduric micro-organisms growing on tooth surfaces not reached by the toothbrush. This is usually called the Miller theory. Bunting and the bacteriologists of the University of Michigan group believe that the organisms are strains of *Bacillus acidophilus*.[52-55] Recent observations of groups working at the University of Toronto[56, 57] and at Columbia University[58, 59] lend support to this belief. Rettger, at Yale University, has always objected to this terminology and has recently reported[60] that the organisms involved are predominantly streptococci. The Northwestern University group presents evidence[61, 62] of the possible symbiotic relationship of several mouth organisms, including yeast, *Bacillus acidophilus* and *Bacillus subtilis*. In this review, no attempt will be made to say who is right and who is wrong. Except when considering the specific work of one or the other of these groups, the general term "aciduric micro-organisms" will be used to designate oral micro-organisms capable of producing high concentrations of acid and of living in this highly acid environment. If it is ever found possible, by a vaccination method, to produce an artificial immunity in persons very susceptible to dental caries, the correctness of the bacteriologic theory will be irrefutably established, as well as the specific nature of the organism involved.

There seems to be a general impression that, among civilized persons living under normal conditions, immunity to caries as well as extreme susceptibility is an inherited characteristic. The University of Michigan bacteriologists have submitted evidence[54] that the organism which they call *Bacillus acidophilus* is consistently absent in the mouths and usually in the stools of the truly immune, regardless of the diet, and that efforts to implant these bacilli in the bodies of such persons were unsuccessful. They found this organism to be consistently present in high concentration in the saliva of persons showing a marked degree of caries activity. Skin tests, which they made with *Bacillus acidophilus* filtrates, had negative reactions in 70 per cent of the caries-free persons studied, whereas positive reactions were obtained in 90 per cent of a group of persons with active caries.

1. *Conditions Affecting the Ability of Aciduric Micro-Organisms to Grow in the Mouth.*—If the growth of aciduric organisms on the teeth is the primary cause of tooth decay, these organisms must have to be supplied with suitable food for the elaboration of acid. Starches and sugars would seem to be the most probable food constituents involved. Studies on the relation of dietary starch and sugar to the concentration of aciduric

organisms in saliva produced by stimulation have been reported by the Michigan group, using the Hadley quantitative method.[52]

A few of these reports will be discussed briefly. Some of these studies were conducted over a period of years on children living in an orphanage.[26] The regular institutional régime had caused arrest of caries activity in a high percentage of the children. Detailed studies of the customary food intake made at different seasons and with various age groups disclosed the fact that the very starchy institution diet was below accepted standards of adequacy for growing children in calcium, phosphorus, protein, calories and probably some of the vitamins. The one factor in the diet that seemed to offer a possible explanation for the unusual arrest of caries activity was its very low content of added sugar, only from 2.8 to 3.4 per cent of the average daily caloric intake being from this source. When quantitative estimations were made of the concentration of *B. acidophilus* in the saliva, the organism was found to be consistently absent from the mouths of many of the children. From early in January 1935, candy *ad libitum* was supplied to fifty-one of the older boys and girls for five months as a supplement to their regular high-starch, low-sugar institution diet. Figures have been reported[55] for each of these children expressing average numbers of these organisms per cubic centimeter of saliva. These averages were calculated from weekly determinations made: A, for the three weeks before candy became available; B, for the five months of the candy period, and C, for the three weeks following discontinuance of the candy. Only four of these children showed consistent absence of *Bacillus acidophilus* from the saliva in all three periods. These children were probably truly immune. In 80 per cent of the children, there was increased concentration of aciduric organisms in the saliva during the candy period, whereas among the 128 other children studied, who were, presumably, receiving no candy, the counts increased in only 26 per cent of the cases. (We had reason to believe that some of the group of 128 had more or less frequent access to the available candy.) Within the candy group, *Bacillus acidophilus* appeared in the saliva of some of the children within two days after candy was introduced into the diet, after being absent for the five or six preceding months. A drop was noted in the concentration of aciduric organisms in the saliva during the third period in most of the 80 per cent in whom the counts had increased during the candy period.

Other studies have been reported[27] by the University of Michigan group on hospitalized children on controlled adequate diets. Ten of these children received, for many weeks and months, enough candy to average 16.4 per cent of their daily caloric intake, in addition to the 5.6 per cent from sugar added to foods included in their basal diet. The intake of fundamental foods in the basal diet remained very satisfactory during the periods of candy consumption, although it is recognized that under ordinary home conditions this would not be true. In seven of these ten cases, marked increases were noted in the concentration of *B. acidophilus* in the saliva. One of the seven, after a year on the high sugar régime, remained under observation for six months without candy on a modified basal diet providing only 1.9 per cent of her average daily caloric intake as added sugar. During the last two months of this period, *B. acidophilus* was absent from her saliva. The other three of the ten children to whom candy was given *ad libitum* had never had cavities in their teeth. The regular use of all of this additional sweet food, for 270, 114 and 279 days, respectively, made no difference in the saliva. In one case, the saliva was

always negative; in the two others, this was the usual case, but there were a few times when small numbers were found.

The Michigan group has also studied a number of persons who were very susceptible to caries. Five of the hospitalized children[27] on the controlled, nutritionally adequate diet could be so classified. In spite of their being restricted to the basal diet in which fresh fruit was substituted for simple made desserts, and the percentage of average daily caloric intake from added sugar being thereby reduced from 5.6 to 1.9, the concentration of *Bacillus acidophilus* in the saliva remained high. Other similar cases from the university dental clinic that were studied showed a high concentration of this organism in saliva on nutritionally adequate diets low in added sugar. For the two months that one young woman[54] was on such a diet, her count remained between 100,000 and 300,000 per cubic centimeter of saliva. Within one month after starch too was eliminated from her diet, the count had dropped to 1,000. Christmas holidays broke her will power and the count jumped to 1,500,000 in two weeks. At the end of the succeeding six weeks on the low-starch, low-sugar diet, her count was negative for the first time. Resumption of the use of starch, but not sugar, caused it to rise again to 100,000 during the following two weeks.

The Michigan group feel justified in concluding that aciduric micro-organisms measured by the Hadley technic obtain their food supply very easily from concentrated sweets. If it is impossible for these organisms to grow in the body, sweets may be eaten with impunity. Such persons are doubtless hereditarily immune. If a person has an average susceptibility to caries, and the orphanage studies indicate that about 70 per cent or more of children belong to this class, liberal use of concentrated sweets, whether the diet is adequate nutritionally or not, will increase the concentration of aciduric bacteria in the mouth. The converse is also true. The practical elimination of concentrated sweets from the diet will cause the disappearance, or a marked decrease in the concentration, of these organisms, perhaps more quickly if the diet is nutritionally complete. If a person is very susceptible to caries, there is no practical dietary method that will eliminate these organisms from the mouth. Diets containing no starch except in the form of low carbohydrate vegetables with the sugar content limited to that found naturally in milk and juicy fruits are, if adequate nutritionally, very expensive, owing to the high cost of meat, eggs, cream and other palatable fats. Such diets are also too different from healthy civilized man's customary diet to make adherence to them possible except for periods of from four to eight weeks.

Hoppert and his colleagues at Michigan State College developed a successful method for producing caries in the molar teeth of white rats.[30] Two types of diet were used, one caries-producing and one not. The diets were identical in every respect except for the consistency of the cereal component.[30, 32] In the caries-producing diet, the cereal (rice or corn) was ground to the consistency of sand; whereas, in the non-caries-producing diet, the same kind and amount of cereal was ground to resemble fine flour. The Michigan group reported studies of the effect of these two diets on the mouth flora of rats in contrast with the effect of a starchless, sugarless high-protein diet.[54] They found *Bacillus acidophilus* in the mouths of all rats on the two Hoppert diets, but absent from the mouths of rats on the carbohydrate-free diet. They suggest that possibly in Hoppert's observation as to the relative impermeability to moisture of the finely ground non-caries-producing diet lies the explanation for the failure of this diet to cause caries. Such a diet may not permit enough inter-

mixture with saliva to make fermentation possible. The Michigan group observed that, when rats on this finely ground Hoppert diet were examined postmortem,[31] the intact molars were impacted with white masses of dry material almost as hard as cement, whereas the carious molars of the rats on the coarsely ground Hoppert diet, which is readily permeable by moisture, were impacted with wet soft sticky brownish material. Naturally, we should not draw the conclusion from such data that human caries is caused by eating raw coarse cereal, for we know that civilized persons rarely consume uncooked cereals. We again emphasize that caries is a common disease among civilized persons. However, the lesson we can learn from these studies and which may be applied in studies of the human disease is that food can and does affect caries incidence through its effect on the environment of the tooth in the mouth. Hoppert diets, whether caries-producing or not, are unquestionably complete nutritionally.

Is it possible that the freedom from caries exhibited by Eskimos on their native diet is to be explained by the fact that they eat almost no starch or sugar, nothing, in fact, from which aciduric organisms can manufacture acid? The recent bacteriologic studies of the saliva of Eskimos conducted by Rosebury seem to support this possibility. Then, too, other primitive peoples who are known to be singularly free from caries rarely have access to concentrated sweets. They may chew sugar cane, but this sap is low in sugar as compared with our sweet desserts and candies. Jeans and Boyd have argued[63] that because certain children under their observation who had celiac disease and were given dextrose solution orally did not develop active caries, sugar intake bears little if any relation to caries susceptibility. The sugar solution given in such cases is not concentrated and has little or no contact with the teeth. Their argument does not seem to settle the question.

It is generally accepted that possibilities for food retention are maximum when teeth have deep pits or fissures, or are crowded and irregularly arranged, or are not kept clean under the gum line. Such conditions likewise offer a greater degree of protection for colonies of micro-organisms that may infest the mouth. It is in such favored locations that cavities originate. Perhaps this is why many persons with hypoplastic or irregular teeth seem to have a higher degree of caries activity than do many persons with normal tooth structure and occlusion. However, some persons of the first type are free of cavities whether their mouths are visibly dirty or visibly clean, whereas some of the latter group have rampant caries even though their mouths are visibly clean.

Is the explanation, then, more logically placed on the kinds of micro-organisms present in the mouth rather than primarily on tooth structure or visible cleanliness? Hyatt's success in reducing incidence of caries in children lies in prompt filling of pits and fissures as soon as an imperfect tooth is erupted. He thereby reduced the hiding places of micro-organisms. Sugar-low diets for persons with average susceptibility and diets low in both sugar and starch for persons very susceptible to caries, and similar diets that are eaten by native Eskimos, act by starving out these offending organisms. Is the rather pointed shape of dog teeth and of typical negroid teeth a possible explanation for their low caries susceptibility? Such teeth offer few, if any, possibilities for food retention and for colonies of bacteria to remain undisturbed on the tooth surface.

Recent evidence as to the possible rôle of the starch-digesting power of saliva has been negative.[35] However, no special studies of this factor have been conducted on persons very susceptible to

caries in contrast with the immune or those with only average susceptibility. In view of the fact that both starch and sugar must be eliminated from the diet of these highly susceptible persons before aciduric organisms can be eliminated from the mouth, such a series of studies should be made.

2. *Ability of Acid Formed by Aciduric Micro-Organisms to Initiate Cavity Formation.*—The acid neutralizing power of saliva may be shown later to play a specific rôle in protecting enamel from acid formed on its surface. Other chemical properties of saliva may yet be found that have significance.

Mrs. Mellanby[4] states that carious teeth have a poor quality of secondary dentin regardless of perfection of surface structure, and that if poorly formed teeth are non-carious, it is because of a strong back wall of secondary dentin. Can the strength of the secondary dentin affect dissolution of enamel by acid formation on its surface?

Those who believe that the primary cause of caries is bacteriologic postulate that the aciduric organisms are held in place on the tooth not only by the presence of favored areas for the colonies, but also because the colonies are covered by an insoluble plaque which the saliva does not penetrate and which is comparatively impermeable to the acid that is being generated underneath. These plaques are probably largely mucin, but we need more information on the effect of diet on their formation and composition. Fisher has reported[64] a method of staining plaques which he asserts shows differences in the nature of films found on carious and non-carious surfaces. If this method is reliable, can it be used to study the relation between various forms and concentrations of sweets eaten and the type of plaque laid down on teeth, and rates of deposition?

3. *Correlation Between Concentration of Aciduric Micro-Organisms in Saliva and Caries Susceptibility.*—The bacteriologists of the University of Michigan group report a high degree of correlation between the concentration of *Bacillus acidophilus* in saliva and caries susceptibility and between the absence of this organism or its sporadic appearance in saliva in small numbers and caries inactivity.

In the hospital group,[27] this correlation was 88.9 per cent; whereas, among twenty-five of the orphanage children for whom bacteriologic data were reported in 1934, the correlation was 84 per cent.[26] Among the fifty-one children in the orphanage group to whom candy *ad libitum* was given,[55] only seven (13 per cent) had shown clinical evidence of caries activity during the preceding year, whereas twenty-three (44 per cent) developed cavities during the five months of candy administration. All but two of these twenty-three children had shown an increase in concentration of *B. acidophilus* in the saliva during this time. Twelve of the twenty-five children who did not develop cavities had increased counts during the candy period. The time may have been too short for positive results to become evident.

The Toronto group,[56, 57] employing the Hadley technic in a study of thirty-nine institution children who were under observation for more than a year, found only six who gave consistently positive salivary *Bacillus acidophilus* counts. Five of these developed new cavities. The diet in this institution was superior nutritionally to that in the orphanage in which the Michigan studies were made, but it was also low in sugar. *Bacillus acidophilus* was never found in the saliva of twenty-two of the children. Of this group, eighteen remained free of caries, two showed slight progressive caries and two were doubtful cases.

Rosebury[59] recently studied the concentration of *Bacillus acidophilus* in the saliva of 106 Eskimos, using the Hadley

method. In thirty-six cases showing active caries, 80.6 per cent gave positive reactions, the counts averaging 122,350 per cubic centimeter of saliva. There were forty-four who had never had caries, all of whom were accustomed only to their natural diet. Of this group, 13.6 per cent showed positive counts averaging 2,570 per cubic centimeter. There were twenty-six cases of doubtful caries activity. Of this number, 42.3 per cent were positive, their salivary counts averaging 34,290 per cubic centimeter. The concentration of yeast colonies and their presence or absence showed much lower correlation with the caries-activity picture. Rosebury believes that these findings support the work of the Michigan group.

Anderson and Rettger,[60] on the contrary, found only 18.5 per cent of a group of sixty-one caries-susceptible with *Lactobacillus acidophilus* in the saliva, whereas 84.6 per cent of them showed acidogenic streptococci. They state that large numbers of organisms continuously producing small amounts of acid may be as important factors in caries production as more highly aciduric types.

The Northwestern University group[65] has developed an interesting method for diagnosing caries susceptibility. They incubate approximately 30 cc. of saliva, produced in chewing ordinary chewing gum and made up to contain 5 per cent of glucose, for four hours at 37° C. with ground human enamel. Calcium determinations on the saliva are made before and after incubation. Their data indicate that, under such conditions, the saliva of the susceptible dissolves considerably more of the calcium from the ground enamel than does the saliva of caries-inactive persons. They believe their work justifies the use of this method as a diagnostic aid and as a means of testing the success of various efforts to control caries activity. Undoubtedly, the test depends on the formation of acid by bacteria present in the saliva. The advantage of its use over the Hadley technic, if it proves usable in the hands of other scientists, would lie in its simplicity and resultant saving of time as compared with the Hadley method.

SUMMARY

It is generally accepted that the nutritional adequacy of the diet is of fundamental importance from the prenatal period through adolescence, in the formation of a sound, healthy body and of well-formed and well-enameled teeth with satisfactory occlusion. It is equally important throughout life in the maintenance of the general health and the health of the parodontal tissues.

The theory that food intake affects the integrity of the erupted tooth chiefly through making conditions possible or impossible for aciduric micro-organisms to infest the mouth and produce acid on protected tooth surfaces seems to be the only logical explanation for many known facts about the occurrence and unusual nature of this disease. Among these facts are these:

1. It has been impossible to produce caries in most experimental animals. Its recent production in rats was brought about by dietary conditions affecting the environment of the molars.

2. Not all teeth in the mouth are equally susceptible.

3. Cavities begin in highly protected areas on the outside of the tooth.

4. Not all poorly enameled teeth are susceptible to caries.

5. Not all well-enameled teeth are free from caries.

6. Some persons are free from caries even though their diets have long been very inadequate nutritionally.

7. Other persons are susceptible to caries even though they have long been accustomed to well-balanced diets.

8. Caries can be produced in persons on well-balanced diets by additions to

the diet of such a nature that their only known measurable effect is the increase in concentration of aciduric organisms in the saliva.

The nutritional adequacy or inadequacy of the diet may be a factor in determining the rate of progress of caries, but is probably not its primary etiologic agent.

Saliva may contain a factor or factors that minimize the effect of acid formed on the tooth surface. The nature of this factor is not yet known.

The nature of true immunity is not yet known. It is doubtless an inherited characteristic. There is evidence that it inhibits the growth of certain aciduric micro-organisms in the body.

There are many legitimate reasons for recommending that the diet of children and adults be nutritionally adequate. If, at the same time, the use of concentrated sweets is reduced to an absolute minimum, there is the greatest likelihood that the incidence of caries in the civilized population of the world will be reduced to a minimum.

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HISTOLOGIC VERIFICATION OF RESULTS OF ROOT-CANAL THERAPY IN EXPERIMENTAL ANIMALS

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THE relentless, unceasing search for the perfect root-canal filling continues. That this is a fact becomes evident as one reviews the literature on this problem. After studying the results obtained by Gottlieb, [1-4] Orban,[5,4] Stein, [1, 3, 4, 5] and Schwarz[1] in studies of thousands of root-filled teeth in experimental animals, one immediately realizes the vast amount of research which has been undertaken to find a satisfactory root-filling material.

The root-canal problem has many phases, but, in this experiment, we confine ourselves to a histologic study of the effects of the application of various medicaments to sterile and infected parodontal tissue and the tissue tolerance of a previously determined sterile periodontal membrane for the filling material.

We have been fully aware of the limitations of the roentgenogram, particularly in the diagnosis of apical parodontal disease. There are far too many incipient infections about the apices of teeth which are not revealed by the x-rays. Puterbaugh,[6] in 1926, said, "It is hoped that time will bring exact methods of determining successful fillings, but, at present, the radiogram with its deceptions and limitations must be relied upon to disclose the character of fillings and the degree of tissue tolerance." Here we believe that transillumination, if more fully understood and interpreted, would be a valuable aid in diagnosis. This is an important field for investigation.

Histologic methods are now available to study root-canal therapy in necropsy material; i.e., human material, as well as that from experimental animals. It is generally conceded by researchers in this field that the histologic control of root-canal treatment, wherein the microscope tells what is happening in the parodontal tissue, is the only scientific means of studying various methods of procedure. Utilizing the present histologic methods to study our problem, we ask what constitutes, histologically, the perfect root-canal filling material? We are not concerned at this time with the clinical manifestation, but with the histologic or microscopic findings, which we believe should be unquestioned. It was the aim of one of us (U. G. R.) to compound a root-canal filling material that would successfully seal the apical third of the root and, at the same time, be sufficiently well tolerated not to cause inflammation. We can postulate the following results from the use of such a root-filling material:

1. The reaction of the parodontal tissues to the use of the filling material must be "bland."

2. The lateral or secondary foramina as well as the main canal must be sealed with either filling material or new (secondary) cementum, preferably the latter.

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3. Conditions in paragraphs 1 and 2 must apply to both infected and so-called "vital" cases (non-infected vital teeth from which the pulp tissue has been removed).

THE LITERATURE

A great deal has been written concerning the root-canal problem, but we must limit ourselves to the articles which give specific information on this particular phase of the problem. We shall give brief reports of experiments carried on by Gottlieb, Orban, Stein and Schwarz. Gottlieb, Orban and Stein,[3] in 1932 studied infected cases five months to one year after the root canals were filled. The filling material used was composed of 5 per cent paraform (trioxymethylene) in zinc oxide. Some teeth were overfilled to study the reaction of the parodontal tissues to the filling material. The authors reported localized foci composed of both cellular and serous exudate. Periapical abscesses were observed in some cases.

Gottlieb, Orban and Stein[3] also, in 1932, studied vital cases in dogs at necropsy from one week to six months after the pulp was removed and the canal filled. Five per cent paraform (trioxymethylene) in zinc oxide was used as the root filling material.

Fig. 1. (Case 3-E).—Upper left cuspid showing chronic exudative apical parodontitis. This case was not treated but remained as a source of essential infection throughout the experiment. Insert: Diffuse rarefying osteitis.

The vital cases which were not overfilled showed normal secondary cementum over the apex in many instances. Some cases showed serous exudate with varying numbers of wandering cells. Other cases showed abscess formation at the lateral canal openings, resorption

of cementum and alveolar bone resorption.

Stein[5] also, in 1931, contributed to our knowledge on the subject with his experimental root treatment. In experiments carried on in 1927, dog's teeth were either left open or infected by inoculation with a streptococcus isolated from the apex of a human tooth. The cases infected with streptococcus were sealed. After a period of many weeks, periapical areas could be demonstrated by roentgenograms. These granulomas were similar both roentgenographically and histologically to human granulomas. Half of the dogs died before treatment was begun and the remaining dogs died during treatment. Necropsy revealed septic organs in several dogs.

TREATMENT

Canals were enlarged with a No. 6 file by chemical and mechanical means. Various medicaments were used for treatment: diathermy, 50 per cent nitrohydrochloric acid, neoarsphenamine, perhydrol, alcohol and antiformin(sodium hypochlorite).

Root-Canal Filling Material.—Powdered silver-iodoform cement (equal parts of silver and slow-setting cement—silver cement) and chloropercha and gutta-percha points with iodoform. Silver cement showed a decrease in rarefying osteitis by roentgenographic examination seven months and two days after the root was filled. Histologically, it showed cellular infiltration, root resorption and separation of the filling material from surrounding tissue. Chloropercha and guttapercha points with a mixture of iodoform produced a cell-poor connective tissue about the excess filling material, with evidence of phagocytosis. In his summary, Stein states that the marrow spaces about the treated roots were larger than those in the untreated cases and contained tissue rich in exudate which was not present in the untreated cases. This he believes was due to the method of treatment. We wholly agree with him when we study the drugs used to treat these cases. The teeth were washed out with perhydrol and alcohol sublimate and the canals were dried with cotton points.

In 1933, Gottlieb, Orban, and Stein[4] again reported on root canal treatment in the case of a live pulp. The preparation of the teeth and the removal of the pulp were carried out under aseptic conditions. Canals were enlarged with a drill and (this may account for the many overfilled canals) were repeatedly

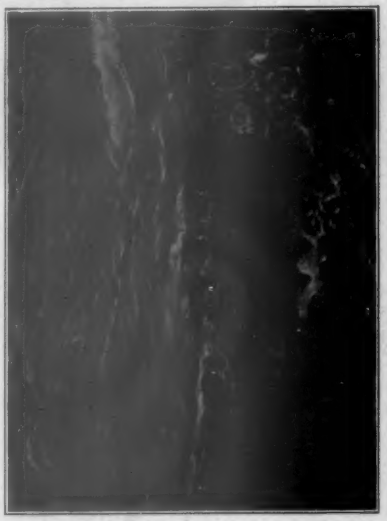

Fig. 2.—Higher magnification of Figure 1, area A, showing fibroblastic proliferation at left; lymphocytes, plasma cells and thin-walled blood vessels on right. The leukocytes are so few that none can be seen in this field, showing a transition from an active purulent to a chronic productive apical parodontitis.

washed with hydrogen peroxide. Phenol camphor diluted with water sublimate was used to treat these vital cases. This form of medication for the treatment of vital cases in which there is no suspected infection seems rather drastic to us. It would be quite caustic to the periodontal membrane in case any of the

Fig. 3. (Case 36-E).—Infected case. Below: Distal root of lower left molar one year and five months after root-canal therapy, showing resorption line at R, secondary cementum at SC and normal periodontal membrane at PM. Above: 12-13-32, original condition, before work was started; 3-25-32, rarefying osteitis three and one-half months after inoculation; 5-23-33, root-canal filling after two sterile cultures; pathosis still perceptible; 10-20-34, condition at necropsy; pathosis less perceptible.

medicament seeped through the apical third of the root and undoubtedly would produce necrosis.

In this experiment, the following filling materials were used: (1) cement with guttapercha points; (2) equal parts of cement and dog dentin; (3) equal parts of cement and pig dentin or ivory dust; (4) Albrecht's substance (contents not available); (5) cement and human pulverized dentin (kind of cement not stated).

Oxyphosphate cement liquid (phosphoric acid) was apparently used to mix the foregoing powder combinations. The results were favorable in one respect in that secondary cementum was produced about the apices and ossification of the excess filling material took place. However, phagocytosis was also present. The use of pig dentin and cement was not so successful. Small areas of inflammation were present wherever the filling was pushed beyond the apex. The use of Albrecht's substance produced no inflammation in the periodontal membrane.

Gottlieb, in 1936,[2] at the Ninth International Dental Congress, reported on the present status of the root treatment question. As a result of much investigation and experimentation to obtain an adequate root-canal filling material, Gottlieb set forth the following hypothesis:

1. To be able to produce secondary cementum within the main canal and lateral canals and also have a normal periodontal membrane.

2. With necrotic tissue in the pulp and dead cementum over the apex, can this dead cementum produce new cementum?

3. Do we have a root-filling material which is plantation positive and which will be partly resorbed and replaced by a continuous layer of living cementum?

These requisites for a suitable root-canal filling material set forth by Gottlieb are quite similar to the hypotheses set up for the experiment to be reported in this paper. In this work, Gottlieb studied histologic reactions of infected (gangrenous pulps) cases. Necropsies were performed from seven to eight months after the root-canals were filled. The infected cases were filled with a mixture of cement and pulverized dentin from extracted vital human teeth. Histologically, Gottlieb found secondary cementum over the apex and on the sides of the canals, with non-inflammatory tissue in the narrowed lumen. Another case showed secondary cementum surrounding all canal outlets except one, which showed slight inflammation.

Coolidge[7] also reported at the Ninth International Dental Congress in Vienna on the data derived from extracted root-filled teeth. He found, histologically, a deposition of secondary cementum in the presence of a non-inflamed periodontal membrane about the apices of both vital and infected root-filled teeth. He shows roentgenographic and histologic results of a granulomatous case (Fig. 12-13, pp. 1029-1030[7]) nine years after the root-canal was filled with guttapercha. Histologically, he reports complete healing and a non-inflamed periodontal membrane showing scar tissue formation. He also reports scar tissue formation in the periodontal membrane of a vital case of eighteen years' standing. (Fig. 8, p. 1026.[7])

OUR EXPERIMENT

Selection of Experimental Animal.—There has been no definite agreement among research workers in the past, more particularly in this country than abroad, relative to the experimental animal which will give similar histologic reactions to those observed in the mouths of human beings. Histologic comparisons of root-end involvements in the dog, showing this similarity, have been made by Stein[8] and verified by Siegmund and Weber, and Euler and Myers. Gottlieb, Orban and Stein,[2] in 1932, reporting on the problem of root canal treatment at the Eighth International Dental Congress,

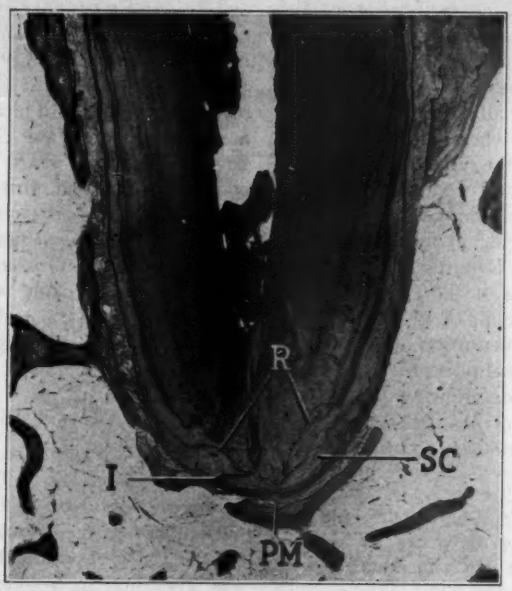

Fig. 4. (Case 9-E).—Infected case. Below: Distal root of lower left molar seven months after root-canal therapy showing obliteration of lateral foramen (I) by secondary cementum (SC); resorption line (R); normal periodontal membrane (PM). Above: 11-30-32, original condition; 3-25-33, rarefying osteitis four months after inoculation; 5-20-33, root-canal filling, rarefying osteitis still perceptible particularly around distal root; 5-25-33, mesial root refilled (excess filling); 12-27-33, seven months after root-canal filling; pathosis still perceptible around apices, especially distal.

in Paris, made the following statement: "There is no good reason to assume that the dog is less sensitive to possible injury induced by root-canal treatment than any other animal or human being. Indeed, the frequent occurrence of poor results in

dogs stands as evidence in support of this idea." Orban[8] stated, in 1932, that "it has been clearly demonstrated and accepted in Paris that the parodontal tissues of dogs are very sensitive to any kind of injury." He continues by saying that owing to this greater sensitiveness, the difficulty of treating dogs' teeth is increased, but that this difficulty is most welcome because, if we can successfully control the root-canal problem in dogs, we shall undoubtedly have greater success when we apply this root-canal therapy in treating the teeth of human beings.

Hill[9] comes to the conclusion in his study of experimental granulomas in dogs that both "morphologically and histologically, granulomas in dogs are comparable to human granulomas." However, there remains a doubt in the minds of certain investigators as to the justification for the use of the dog. From the reactions observed in our experiments, we are completely in accord with the European group in the selection of the dog as our experimental animal. The dog is an omnivorous mammal and is biologically similar to man, as may be clearly demonstrated from the character of the inflammatory reactions in the histologic sections. The importance of the selection of the experimental animal could very readily be made the subject of a separate paper, but we wish only to mention it here to uphold our findings.

Fig. 5 (Case 38-E).—Infected case; lower left anterior tooth one year and five months after root-canal filling. A chronic exudative and productive apical parodontitis is present. This reaction also shows a transition from an active purulent to a chronic productive infiltrate.

Anesthesia.—After trying several types of anesthetics, it was finally decided that pentobarbital sodium (nembutal) was the safest and best suited for our needs.

Types of Cases.—Infected cases and the so-called "vital" cases were studied. The infected cases were initiated by inoculating teeth from which the pulps have been removed, with a twenty-four hour culture of *Streptococcus viridans* isolated from the root-canal of a clinic patient. The non-infected, so-called vital cases comprised teeth from which vital pulps had been removed.

Treatment.—The infected cases were treated after alveolar bone destruction was perceptible in the roentgenograms. The length of time required to produce radiolucent areas of alveolar bone destruction about the apices varied from seven weeks to four months. Formocresol was used in the treatment of the infected cases. The vital cases were treated with oil of cloves, a mild antiseptic. This type of drug was used because its mild analgesic properties would not produce necrosis if it was carried beyond the apex or seeped through the accessory foramina.

Filling Material.—A sealer (Rickert) used as the root-canal filling material throughout the experiment in both infected and vital cases is composed of the following:

Powder

Zinc oxide C.P.	41.21 per cent
Silver precipitate (metal) C.P.	30.00 per cent
White rosin U.S.P.	16.00 per cent
Thymol iodide U.S.P.	12.79 per cent

Liquid

Oil of cloves U.S.P.....78 per cent
Canada balsam U.S.P.....22 per cent

General Data.—It was planned that the experimentally filled teeth, both infected and non-infected, from one dog should be used for bacteriologic studies and that, from a second dog, histologic studies were to be made of the root-filled teeth with their surrounding structures. The experiment was to continue for one and one-half years after completion of the root-canal operation.

The upper incisors were to remain infected throughout the experiment, to be a source of essential infection in the experimental animals. These two teeth were inoculated several times.

Procedure.—At the beginning, we should like to emphasize the necessity of strict asepsis in carrying out root-canal operations. Regardless of whether we are dealing with infected or with vital noninfected cases, it is of paramount importance to avoid contaminating ourselves and the equipment. It is also important to avoid reinfecting the patient with virulent material taken from infected canals or inoculating the vital cases with organisms from non-sterile instruments or from an unsterile field. Everything that goes into a canal should be sterile. This is the first and last requisite to successful root-canal operations.

The root canals are enlarged when necessary by mechanical means (files) to permit easy manipulation of the filling material. Dental burs are never used to enlarge canals in either experimental work or private cases. The apex of the tooth should never be perforated intentionally with a file. This eliminates pushing necrotic pulp tissue or toxic substances through the apex, bringing them in contact with the periodontal membrane and alveolar bone; which would in most instances result in unnecessary pain after a period of time.

After the canals have been enlarged, treatment is started, formocresol being used in the infected cases and eugenol or oil of cloves in the vital cases. Treatments are repeated until two sterile cultures are obtained. A guttapercha point is selected in accordance with the diameter and the length of the canal. This point is carried to place in the canal and roentgenograms are taken to ascertain its position. It is advisable to select the guttapercha point before the canal has been pronounced sterile. During the selection of the guttapercha point and the sealing for the roentgenograms, the aseptic chain may be broken, even if one is assured of the sterility of points, instruments, etc. The selected point can be resterilized in metaphen, a 1 :500 solution. Therefore, there will be less possibility of contamination if several treatments follow the selection of the guttapercha point.

After the gutta-percha point is selected and the canal pronounced sterile, everything is in readiness to place the root-canal filling. A sterile field is prepared with the tooth or teeth isolated. The sealer is mixed to a creamy consistency and small portions are carried to the canal to serve as a lining and to seal the apical foramina. The selected gutta-percha point is covered with the sealer and, by several pumping strokes, is carried to place with the sealer ahead of the point. It is important that the sealer precede the gutta-percha point so that the sealer comes in contact with the periodontal membrane. This sealer was the blandest of all the root-filling materials tested by us for tissue tolerance in 1931[10] and 1933.[11] After the selected point is in place, additional very fine points are carried into the canal and condensed with a tapered instrument (spreader) until no more can be placed. This produces a very hard core of guttapercha. Roentgenograms are taken at this time to study the position and condensation of the root filling. If necessity

Fig. 6. (Case 9-E).—Infected case. Below: Mesial root of lower left molar seven months after root-canal therapy; sealer (KS) beyond apex surrounded by scar tissue and fibroblastic proliferation (X). (Compare Fig. 7, high power magnification.) Above: 11-30-32, original condition; 3-25-33, rarefying osteitis four months after inoculation; 5-20-33, root-canal filling, rarefying osteitis still perceptible particularly around distal root; 5-25-33, mesial root refilled (excess filling); 12-27-33, seven months after root-canal filling; pathosis still perceptible around apices, especially of distal root.

demands the removal of this filling material, for the purpose of refilling or for culturing the apex at a future time, it can be accomplished within a very few minutes by softening the guttapercha with xylene or eucalyptol. All or part

of the root filling can be removed, this depending on the need of the particular case.

RESULTS

Bacteriologic Data.—In one experimental animal, both the infected and noninfected teeth were cultured before necropsy, by the window method. This method has been used for years by the late Chalmers J. Lyons, and by John W. Kemper, of the oral surgery department, and by one of us (U. G. R.) from the therapeutics department, and has proved very satisfactory. After a sterile field was prepared, an incision was made several millimeters above the gingival margin, a thin strip of tissue being left to which to suture. The incision was carried in a crescent shape, over and somewhat beyond the apex of the tooth. The same type of incision is made for an apicoectomy except that it is made somewhat wider to give greater access to the field of operation. The mucous membrane flap was held back with retractors and the alveolar plate was removed, to expose the apex to be cultured or resected, or both. The culture material was handled in essentially the same manner as those prepared by the Rosenow method.[12] Control cultures were made by scraping the area about the apex and transferring the inoculum to a suitable culture medium (0.2 per cent glucose, 0.1 per cent agar, ascitic fluid and beef infusion broth). This semisolid medium, as it is called, is used to culture teeth in the University of Michigan root-canal clinic and is very satisfactory for growing all types of organisms associated with infected root-canals.

Cultures made by the Rosenow method after five days' incubation all showed spore formers and *Staphylococcus albus.* These, no doubt, were the result of contamination due to the method by which the cultures were obtained. After incubation of seven days, control cultures showed no growth except one, a spore former of the usual air contaminant type.

Fig. 7.—Infected case. (Higher magnification of Fig. 6, X.) The noninflammatory fibroblastic proliferation (FP) adjacent to the excess sealer (KS) demonstrates the actual tolerance of the parodontal tissues to this material.

Roentgenographic Results.—Complete roentgenographic studies were made in addition to the histologic studies. Although the roentgenogram is of secondary value to a histologic study, it unquestionably should be included in a study of root-canal surgery. Roentgenograms were made prior to beginning the

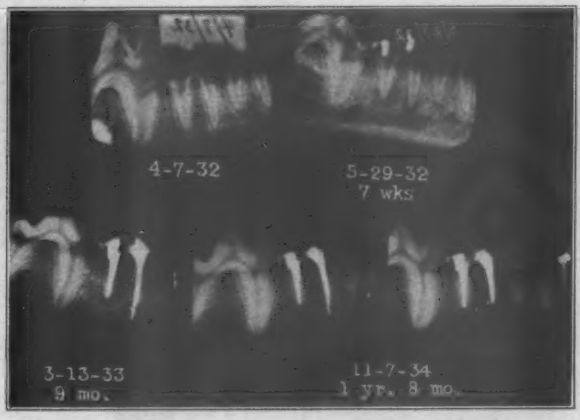

Fig. 8 (Case 61-E).—Infected case; lower left molar one year and eight months after root-canal filling. The mesial root was resected for bacteriologic study (negative culture), the distal root retained for histologic study. Diagnosis (distal root): Mild chronic productive apical parodontitis showing newly formed cementum (C), beyond previous resorption (R). Above: 4-7-32, original condition; 5-29-32, rarefying osteitis around mesial and distal roots seven weeks after inoculation; 3-13-33, condition immediately after root-canal filling; pathosis quite perceptible around distal root and also mesial; 11-7-34, before necropsy, before and after apicoectomy. It is of interest to note the marked decrease in translucency as one compares the roentgenogram taken May 29, 1932, with the one taken November 7, 1934, one year and eight months after the root-canal filling. This decrease in the rarefying osteitis as evidenced by the roentgenogram agrees with the pathologic diagnosis.

experiment in order to study the existing conditions and at various intervals after the inoculation of the teeth to determine the presence or absence of granulomata. These lesions were demonstrable from seven weeks to four months after inoculation. Roentgenograms showing these areas accompany the histologic sections.

One and one-half years after the completion of the root-canal treatment, we can, in some instances, detect the presence of new bone formation about the

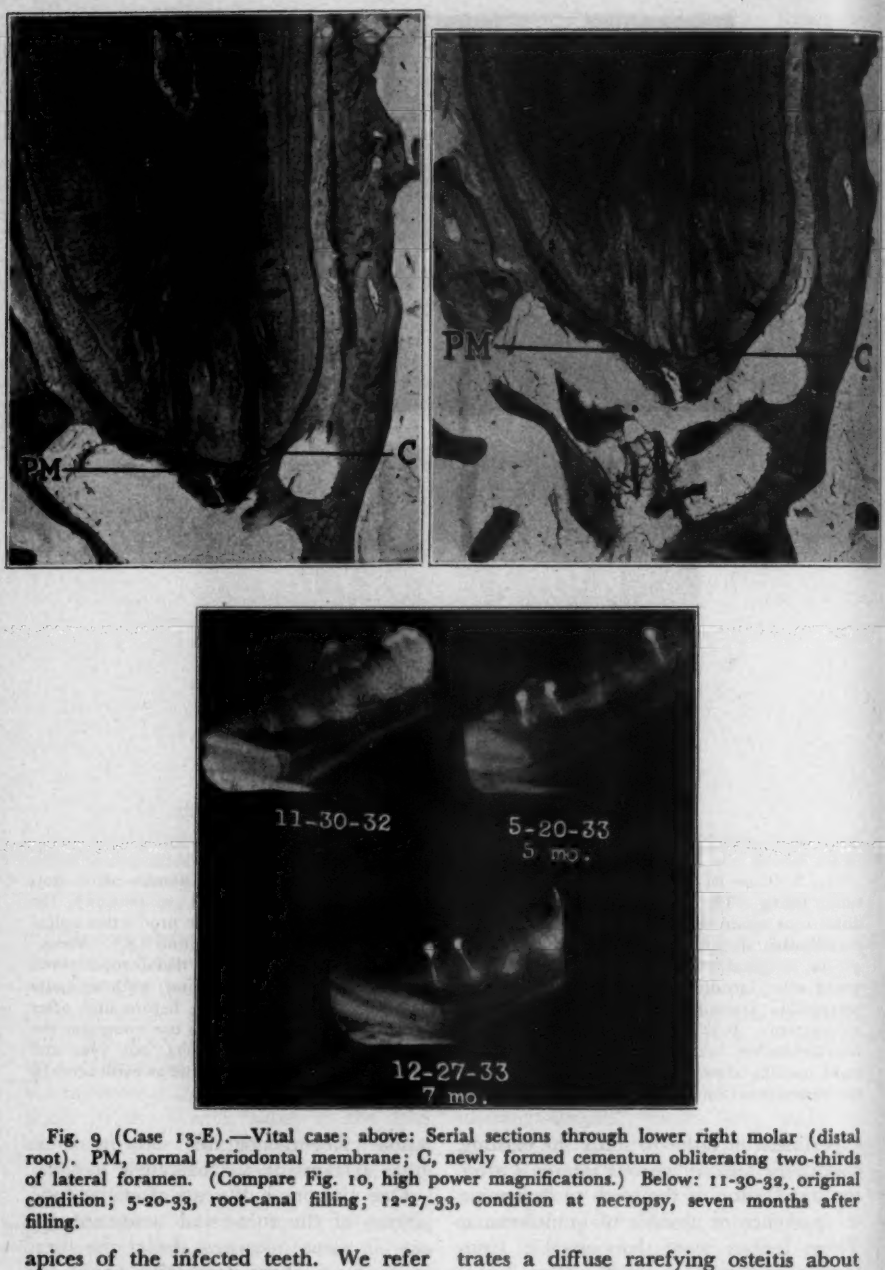

Fig. 9 (Case 13-E).—Vital case; above: Serial sections through lower right molar (distal root). PM, normal periodontal membrane; C, newly formed cementum obliterating two-thirds of lateral foramen. (Compare Fig. 10, high power magnifications.) Below: 11-30-32, original condition; 5-20-33, root-canal filling; 12-27-33, condition at necropsy, seven months after filling.

apices of the infected teeth. We refer here to Figure 8, Case 61E, which illustrates a diffuse rarefying osteitis about both mesial and distal roots seven weeks

after inoculation, in comparison with the roentgenograms taken at necropsy, November 7, 1924. If we compare the roentgenogram taken May 29, 1932 with those taken at necropsy, one year and eight months after the root-canals were filled, we immediately note a diminution in the size of both areas, particularly about the apex of the distal root. Irrespective of the overfilled canal of the mesial root, a decrease in size of the area can be observed in both the nine-month and the twenty-month roentgenographic study.

The non-infected cases present a normal picture of the parodontal structures throughout the experiment. (Fig. 9, Case 13E; Fig. 11, Case 14E.)

Histologic Results.—As it was originally planned to leave two infected teeth as a source of essential infection in the experimental animal, the upper right and left cuspids were not treated. Microscopically, they show a chronic exudative apical parodontitis. (Figs. 1 and 2, Case 3E.)

Infected Cases.—The infected cases showed regeneration by the manifestation of secondary cementum deposited over previously resorbed cementum and normal periodontal membrane over the secondary cementum. (Fig. 3, Case 36E; Fig. 4, Case 9E.) There are, of course, instances in which there was a residual inflammatory process. This is to be expected because the length of time necessary for complete resolution and regeneration would depend entirely on the extent of destruction produced by the induced streptococcic infection. We believe that additional work must be carried on over a longer period of time to ascertain the end-result in such cases. From the one and one-half year cases, we have evidence to warrant an opinion of that picture. (Fig. 5, Case 38E.) This case shows that there was a rather marked reaction at one time, widespread alveolar bone destruction and destruction of cementum, but because we now find a chronic productive apical parodontitis, it presents every evidence of continuing to complete resolution. There is no active alveolar bone destruction at this time. Instead, we have a marked fibroblastic proliferation which embryologically is destined to form new alveolar bone; formation of secondary cementum, and regeneration of periodontal membrane.

The next case (Fig. 6, Case 9E) shows quite a remarkable tolerance toward an excess of filling material. This was the first tooth to be filled, and since the filling was not adequately adapted to the walls of the canal, it was removed. Either in removing the filling material or in refilling the canal, some material was unintentionally pushed beyond the apex. There is scar tissue surrounding an elongated mass of the sealer, somewhat remote, however, from the apex. Figure 7, a higher power photomicrograph of Figure 6, shows a marked fibroblastic proliferation and an ingrowth of connective tissue between the material, which justifies the statement that the filling material is a bland substance and well tolerated. There is, of course, some inflammation present, but we must remember that this was originally an infected case and some residual inflammation should be expected. Another section of the same specimen shows periodontal membrane growing between previously resorbed cementum and excess sealer, and over the outer surface of the same piece of sealer, we see a deposit of secondary cementum. This mass in time may be entirely encapsulated with secondary cementum, since so much is present after seven months.

One of the infected cases of those selected for bacteriologic study (Fig. 8, Case 61E) was of unusual interest. Roentgenograms revealed such definite rarefaction about the apices that we decided to culture the mesial root, which was slightly overfilled, and retain the distal root for histologic study. The culture of the mesial root was negative. The

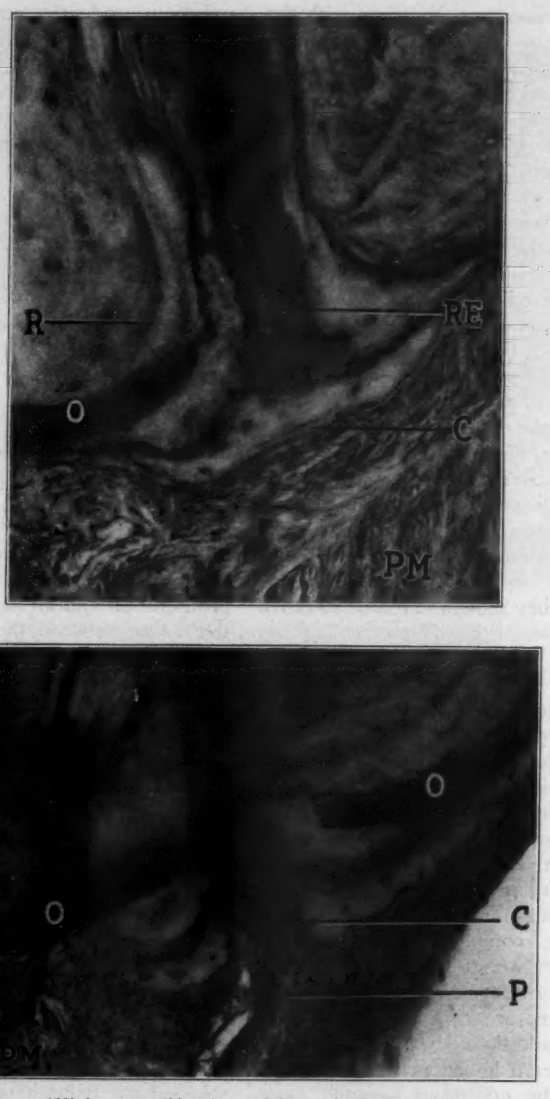

Fig. 10.—Vital case. (Higher magnifications of Fig. 9.) Obliteration of two-thirds of lateral foramen. R, resorption of original foramen; RE, remaining narrowed canal showing blood vessel within; C, cementoblasts in newly formed cementum; O, original cementum; P, pulp remnants in form of mature connective tissue; PM, normal periodontal membrane over apex of root.

pathologic report on the distal root was that of a chronic productive parodontitis and newly formed cementum. The small amount of inflammation present is undoubtedly a residual inflammation, a result of the original infection.

Vital Cases.—Except in one case, which showed a mild productive inflammation, there was no destruction of the alveolar bone or the periodontal membrane. Figure 9, Case 13E, serial sections through a lower right molar (distal root), shows normal periodontal membrane with its various types of fiber bundles and spaces containing nerves and blood vessels. An accessory canal on the right shows an ingrowth of secondary cementum which reduced the lumen to one-third of its original size. A high magnification (Fig. 10) shows this more clearly. Figures 11 and 12, Case 14E, from the same dog, but another vital case, shows secondary cementum extending the entire length of a lateral canal.

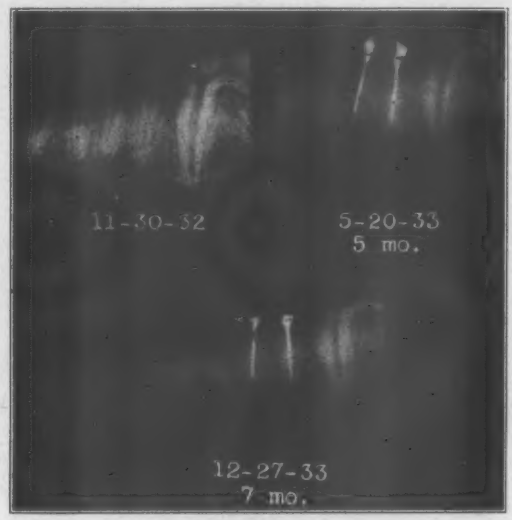

Fig. 11 (Case 14-E).—11-30-32, original condition; 5-20-33, root-canal filling; 12-27-33, at necropsy, seven months after filling.

COMMENT

There has been considerable progress made in the last few years in the biologic control of the root-canal problem through histologic studies. This has been made possible by technical methods which were worked out by Gottlieb and his associates. Kronfeld[13] and Willman[14] have also contributed much to the technical success of these methods in this country.

At the beginning of the report of our experiment, attention was called to the difference of opinion among research workers as regards the use of the dog as an experimental animal. We can now offer additional information from the results of our experiment to justify further our affirmative stand in this matter. Because of the similarity of the histologic reactions observed about the two retained untreated cuspids (Figs. 1 and 2, Case 3E) and the histologic reactions in the mouths of human beings, we believe that the use of the dog is justified for experimental purposes. To explain this further, we see in this inflammatory process a transition from an active purulent process to a chronic exudative and proliferative process, as evidenced by a marked increase in lymphocytes and plasma cells and only an occasional re-

maining polymorphonuclear leukocyte. This transition of the purulent inflammation, as seen in the dog, is identical with that of purulent inflammations in the mouths of human beings, as, for instance, in acute purulent parodontitis, which includes pyorrhea alveolaris and gingivitis, and in apical parodontitis—osteitis and granulomata. If the acute condition is not treated or is unsuccessfully treated and subsequent attacks occur, a gradual transition of the exudate is seen; i.e., from a purulent type exudate to an exudate composed of many plasma cells, lymphocytes and a fibroblastic proliferation resulting in scar tissue formation, the chronic stage of any inflammatory process.

Fig. 12 (Case 14-E).—Vital case; distal root of lower right molar showing two-thirds obliteration of entire length of lateral canal. C', cementum; W, original wall of canal; C, newly formed cementum showing cementoblasts (CB); R, remaining portion of canal; PM, normal periodontal membrane.

Gottlieb, Orban and Stein, in 1932,[2] after the use of 5 per cent paraform

(trioxymethylene) in zinc oxide, reported localized foci of both cellular and serous exudate. Periapical abscesses were observed in some cases. Gottlieb *et al.* did not state the kind of cellular exudate that was present, but they did speak of active phagocytosis about excess filling material. Therefore, we cannot necessarily assume that the exudate was purulent, since there are other types of cells besides polymorphonuclear leukocytes that possess phagocytic properties. However, phagocytosis does represent a defensive reaction on the part of the host against an irritant. The authors gave no bacteriologic report prior to root-canal filling. Therefore, we cannot conclude that the root-canal was infected or that the exudate was produced by the root-filling material or overmedication (treatment not given). It may have been a combination of part or all of the possibilities mentioned.

It is somewhat difficult to account for the residual inflammatory process in the vital cases. It may be due to the irritating properties of the formaldehyde escaping from the paraform material which was used to fill the canals. It is difficult to say how long this inflammation would remain since its etiology is somewhat obscure. Our vital cases showed much more favorable results. (Compare histologic results.)

In 1931, Stein[5] reported his studies of various root-filling materials. He stated that infected cases filled with "radisan" were likely to show large rather than small areas at the end of four months and in no case was there a decrease in periapical areas.

We would like to call attention to the unfavorable results obtained from the use of irritating drugs in the treatment of infected cases. Fifty per cent nitrohydrochloric acid, perhydrol and a strong alkali, such as sodium hypochlorite, were used in treating these cases. If there actually is such a thing as "overmedication," it was certainly carried to the extreme in this instance. After the use of such caustic drugs, there is little doubt that the canal will be sterile. But what happens to the parodontal tissue? Necrosis undoubtedly results.

After a study of the histologic findings, Gottlieb, Orban and Stein,[4] in 1933, believed the cement filling to be the best, but endeavored to improve its tolerance by the addition of pulverized dentin or ivory. In addition to their results, they have further foundation for their belief that pulverized dentin may aid in the regeneration of the parodontal tissues. Other investigators report favorable results from various materials which have been tried experimentally in the healing of fractures. Physiotherapy and bone grafts have been extensively used in this connection. However, the use of the bone graft, or (in better terminology) the transplant, which is the placing of a living or supposedly living tissue in a new bed, applies here only as analagous to the use of heterogeneous bone chips or like substances, which are, of course, non-living tissues. The use of such materials as pulverized dentin and ivory, if carried beyond the root-end in filling root canals or when placed in the operative site after apicoectomy, should be spoken of as an implant, or implantation, the term used for either living or non-living substances.

Beube and Silvers report excellent results in hastening the formation of new bone from the use of heterogeneous bone powder in the jaws of dogs and in surgical cavities. The results of application of such bone powder in human beings in cysts and in alveoloclasia, although harmonious with results of similar experiments observed in dogs, are not sufficiently numerous to give definite conclusions. Here again, the term "implant" should be used. It would be impossible in the treatment of root canals to make use of the prerequisites set up for the transplants; therefore, we must continue to search as has Gottlieb *et al.* for a ma-

Summary of Results of Experimental Root-Canal Therapy*

Procedure								Results of Experiments				
								Before Necropsy				
Author	Date Reported	Type of Case	Preparation of Canals	Treatment	Cultures Before Filling	Filling Material	Duration of Experiment	Roentgenograms	Cultures	Bacteriologic	Roentgenographic	Histologic
Gottlieb, Orban and Stein	1931	Infected	.....	.....	None	5% paraform (trioxymethylene) in zinc oxide cement	Five months to one year	Not reported	No	.....	.....	Localized cellular exudate at apex, and in marrow spaces; serous exudate also present; phagocytosis observed in some areas; less exudate present when apical foramen was not perforated
		Vital	.....	.....	.....	Same	One week to six months	....	....			Serous exudate, no bone resorption; normal secondary cementum; other cases showing abscess formation at openings of canals, bone resorption and arrest of cementum formation
Stein, Georg	1931	Infected†	By chemical and mechanical means—neoarsphenamine or file No. 6	Diathermy or antiformins, 50% nitro-hydrochloric acid, neoarsphenamine. Washed out with perhydrol, sublimate alcohol and canals dried with cotton points	.....	Radisan	Seven months fourteen days	Yes, but not shown in report	.....	.....	.....	Tissue surrounding apex infiltrated with leukocytes and round cells; alveolar bone destruction
						Powdered silver-iodoform cement	Six months six days					Infiltration (†), root resorption and separation of filling material from surrounding tissue
						Slowly hardening cement plus iodoform.	.....					Cell-poor connective tissue encapsulating excess filling material showing phagocytes containing débris, and filling material
						Chlorpercha plus gutta-percha points plus iodoform	Six weeks after infection					Same as above; isolated areas of phagocytosis

						Cement with gutta-		....	.....	.....	.....	No histologic report. Au-

Gottlieb, Orban and Stein	1933	Vital	Opened with drill	Camphor phenol diluted with sublimate water		Cement with guttapercha points Equal parts of cement and dog dentin Equal parts of cement and pig dentin or ivory dust Albrecht's substance	.....	....	.....	.....	.....	No histologic report. Author concludes from histologic results that cement filling is best Formation of secondary cementum on apex, ossification of filling material; areas also showing phagocytosis Small areas of inflammation except when not pushed through apex No inflammation in periodontal membrane (apex not perforated)
Gottlieb	1936	Infected	Opened with drill	.....	.....	Equal parts of cement and pulverized human dentin, (extracted live human teeth), guttapercha points	Seven and eight months	....	.....	.....	.....	Secondary cementum on both sides of canal and noninflammatory tissue in reduced lumen of canal; tissue pulled away from guttapercha point; another case showing secondary cementum surrounding lateral canals except one about which was mild inflammation
Coolidge§	1936	Infected	Chemical and mechanical means (files)	Dakin chloramine 5% aqueous solution. Lugol's solution	Yes, but none reported here	Chlorpercha Guttapercha points	Extracted teeth 10 years after filling	Yes Before extraction	None reported	.....	Comparative study by roentgenogram and histologic examination revealed close similarity in findings by each method	Complete healing, secondary cementum over entire apex adjacent to guttapercha filling, non-inflammatory periodontal membrane showing scar tissue formation
		Vital	Same	"	Same	Same	Extracted teeth 15 and 18 years after filling.	Same	None reported			

*Roentgenograms were taken before treatment and after filling of canals only in the cases of Müller and of the authors (or were not shown or reported). The presence of granuloma was determined after several weeks by Stein and in from seven weeks to four months by the authors. Müller did not state the time.

†Infected with streptococcus or left open to mouth organisms.

‡Used in the treatment of granulomata.

#Greatly discolors teeth.

ıSemisolid medium: 0.2% glucose, 0.1% agar, ascitic fluid and beef infusion broth.

§Report is from conditions found about extracted teeth.

(Continued on next page)

SUMMARY OF RESULTS OF EXPERIMENTAL ROOT-CANAL THERAPY *(Continued)*

Procedure								Results of Experiments				
								Before Necropsy				
Author	Date Reported	Type of Case	Preparation of Canals	Treatment	Cultures Before Filling	Filling Material	Duration of Experiment	Roentgenograms	Cultures	Bacteriologic	Roentgenographic	Histologic
Müller	1936	Infected	Enlarged with pulpalyt	W_2, tricresol formalin or asphalin or silver nitrate Walkhoff's chlorphenol, camphor, methol, iodoform paste‡	.....	Walkhoff's paste‡	Two and one-half years.	Yes	Not reported	Cocci and streptococci in all granulomas	Decrease in size of periapical area or it disappears entirely	New bone formation observed. No organisms found histologically in the granulomas after treatment with water solution of W_2
Dixon and Rickert	1936	Infected	Files	Formocresol	Yes, two negative	Sealer (Rickert) and guttapercha points.	Seven months to one and one-half years.	Yes	Yes	Rosenow method: spore formers and Staphylococcus albus were seen after five days' incubation — contaminations Semi-solid medium‡: no growth after seven days' incubation except in one culture which was a spore former of the air contaminate type.	Diffuse rarefying osteitis seen about the apices of the infected case	Regeneration by manifestation of new alveolar bone, newly formed cementum and normal periodontal membrane
	1936	Vital	Files	Oil of clove or eugenol	Yes, two negative	Same	Same	Yes	Yes		Normal periodontal membrane and lamina dura were observed in the vital cases.	Normal periodontal membrane throughout experiment.

terial which corresponds as closely as possible to the autotransplant.

Just a word in regard to cement as an ingredient in a root-filling material: Its greatest disadvantage is the difficulty of its removal. It is impossible to obtain a culture of root-filled teeth through the canal without removing the cement; which adds to the possibility of contamination at a time when contamination would be most disastrous.

The results obtained by Gottlieb[2] in 1936 with the use of cement and pulverized dentin were very gratifying and demonstrated the possibilities of different filling materials. Gottlieb, however, does not wish to recommend this material for use in man because of the limited number of successful experimental cases.

Gottlieb believes that a filling material, if carried beyond the apex of the tooth, should be of such nature that it will be converted to bone or a bonelike substance free from inflammatory reaction. We agree with Hopewell-Smith's[16] opinion in regard to excess filling material:

> When a filling material is introduced into the bone. it acts as a foreign body which may or may not induce inflammation, may or may not be irritating, may or may not be liable to attack and be absorbed by phagocytes. If the inflammatory reaction to the injury has not been too severe, the induced material may remain innocuous and unresorbed and be tolerated by the living bone, which if non-infected undergoes sclerosis, and an attempt at condensation will result. If on the other hand the induced material is infected, suppuration occurs or the original injury to the tissue continues, resulting in necrosis and abscess formation.

But why overfill teeth to the extent that the filling material comes in contact with the alveolar process? This is not necessary in order to seal the critical, the most porous portion of the root, the apical third. In infected cases, it is advisable to overfill slightly, if a bland material is used, rather than to underfill, but not to the point of contacting the alveolar bone. However, it is an ideal method of studying experimentally the tissue tolerance of the filling materials. Figure 6, Case 9E, from our experiment, demonstrates this point. Here, we have a root canal which was unintentionally overfilled, showing the filling material in apposition with parodontal tissues. Figure 7, a higher magnification, shows histologically a fibroblastic proliferation free from inflammatory cells against the filling material.

Coolidge[7] has demonstrated that much can be learned from histologic sections of extracted root-filled teeth. Unfortunately, this type of material is as difficult to obtain as necropsy material. Coolidge shows histologic and roentgenographic evidence of successful root treatment with chloropercha and guttapercha in both infected and vital cases over a period ranging from nine to eighteen years. Coolidge confirms our opinion in regard to the ultimate healing of small residual inflammation about the induced infected cases; i.e., if we could retain our experimental animals long enough, complete healing would result. This healed condition exists, undoubtedly, at a much earlier period. Our experimental vital cases do not show any evidence of inflammation (scar tissue) in the periodontal membrane, but they do show formation of cementum in secondary canals. (Fig. 9, Case 13E; Figures 11 and 12, Case 14E.)

Coolidge also reports roentgenographic studies of successful cases of from one to twenty years. Although the roentgenograms do not give the histologic status of the parodontal tissues, the satisfactory histologic findings observed in the cases presented strengthen his belief that most pulpless teeth with filled root canals presenting negative roentgenographic evidence would be found to be free from inflammation and infection if studied by histologic and bacteriologic methods. In many instances, we have found this to be true. However, there are many things, such as types of filling material and

quality of roentgenograms, which should certainly be taken into consideration before too much value is placed upon roentgenographic evidence. Gottlieb, Schwarz and Stein[1] say in this connection:

> X-rays do not tell us whether or not the root-filling material is irritating or give knowledge concerning the behavior of the tissue about the root end. The x-rays are of value to show new bone building. In no case, however, can the x-rays be taken as a reliable scientific means of proof.

We have never found any one form of diagnosis entirely sufficient. Transillumination and the clinical condition of such teeth should also be evaluated.

Clapp, in answer to the question: What are the relative merits of transillumination and the x-rays in dentistry? says:

> Any man who depends on only one method of diagnosis is apt to have a large percentage of errors. Neither transillumination nor the x-ray, when taken alone, is reliable. . . . A great deal of harm has been done by proceeding on the evidence or lack of evidence furnished by the x-rays alone.

Attempts were made to study transillumination in conjunction with our experiment, but the oral mucous membrane of the dogs was so intensely pigmented that it was impossible to determine the shadow accurately. Additional work is planned to determine the value of transillumination. There are many incipient areas of inflammation that are not revealed by the roentgenogram.

We cannot agree with the assertions made by Coolidge in his closing paragraph: "The result that may be expected when living pulp is removed and the root canal properly filled is one in which the biological forces of tissue healing and repair are more effective than where pulpless and infected canals are under treatment." It is generally conceded that some form of stimulation, chemical or bacteriologic, certain types of cells, an irritant or an alteration in function or environment should be present to bring about repair, whether it is regeneration in kind or scar-tissue formation. The former is preferable, as scar tissue is a "cheap" tissue which does not function as does normal connective tissue. This stimulus is particularly advantageous for regeneration in transplantation induced by either an autotransplant or an isotransplant. This is confirmed by Boyd,[18] Ebeling and Carrel,[19] Weller[20] and Kronfeld.[21]

It is our belief that a small amount of inflammation promotes regeneration of cementum and periodontal membrane. This is confirmed by Gottlieb.[2] Coolidge, on the other hand, is establishing the same environment when he uses compound solution of iodine (Lugol's) to increase the circulation in the apical periodontal membrane. He is setting up a hyperemic or congestive state which is an alterative inflammation and which undoubtedly, in many instances, goes on to the prestatic stage of congestion, resulting in the exudative phase, exudative inflammation (Weller[20]). Coolidge[7] gives the evidence for this statement in microphotographs showing the production of scar tissue in the periodontal membrane of vital cases, which represents usually more than a mild stimulus, since formation of scar tissue is the result of chronic, repeated or continuous injury to connective tissue. In these vital cases, is this stimulation the result of overmedication or prolonged irritation from the filling material? In either case, regeneration is accomplished even though it is scar tissue formation.

Credit should be given Coolidge for stressing the necessity of sepsis in root-canal therapy and root-canal filling. This is most essential, regardless of the method employed.

CONCLUSIONS

We have shown, through a comparison of histologic reactions observed in the

periodontal structures of dogs and those reactions observed in the mouths of human beings that, since the reactions are identical, we are justified in the use of the dog for experimental purposes.

Our first and third hypotheses have been satisfied by the manifestation of non-inflammatory connective tissue and, in many instances, normal periodontal membrane adjacent to the sealer which was used in filling the root-canals in both infected and non-infected vital cases. (Figs. 6 and 7; Figs. 3 and 4.)

Our second and third hypotheses have also been fulfilled by the manifestation of secondary cementum in the lateral canals in both infected and non-infected vital cases. (Figs. 4, 9, 10 and 11.)

Roentgenographic examination revealed a diffuse rarefying osteitis about the apices of the infected cases and normal periodontal membrane and lamina dura about the vital cases. After one and a half years, the infected cases, in some instances, showed regeneration of alveolar bone.

Bacteriologic studies of both infected and non-infected cases made by the Rosenow method showed contamination after five days' incubation. Duplicate cultures were made in suitable culture media and, after seven days' incubation, showed no growth except in one case, a spore former.

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PROGRESS IN DENTAL PATHOLOGY

By JOSEPH L. BERNIER,* D.D.S., M.S., Washington, D. C.

FOR centuries, the progress of the healing arts has closely paralleled that of man. When man has seen fit to neglect himself, this progress has been slowed. Thus, through the ages, a loosely bound sequence of events sporadically dotted with periods of sincere endeavor and enthusiasm has resulted in a modern and scientific approach to the art of healing. Within the walls of the Army Medical Museum, one may travel through many of these periods of progress, an understanding of which is necessary to the appreciation of our present high level of scientific attainment.

Perhaps one of the most important advances made by the medical profession has been a recognition of the necessity for research in pathology. That dentistry might itself establish a means of furthering this research, the American Dental Association, in 1933, through its museum committee, authorized the establishment of a registry of dental and oral pathology at the Army Medical Museum.

This registry is one of a group of eight now functioning collectively in the museum as the American Registry of Pathology of the National Research Council. The oldest and the most active is that of ophthalmic pathology. This registry has approximately 8,000 cases in its files and is constantly being increased through the cooperation of ophthalmologists in all parts of the country. Much valuable information has thus been obtained, proving beyond all doubt the value to the medical profession of the registry system. For the history of the Army Medical Museum and its registries, I would refer to the excellent paper of Arthur L. Irons.[1]

It is the purpose of this paper to familiarize the members of the dental profession with their registry, its purpose, merits and present status, and to make a plea for its support. The Registry of Oral and Dental Pathology is a collection of pathologic specimens diagnosed, indexed, photographed and filed for the reference of the student, teacher and practitioner. It has as its principal aims the rendering of aid to the practicing dentist in his routine diagnoses and the study of oral diseases. These aims are accomplished by direct histopathologic reports on tissues sent for study, either through local pathologists, and as supplementary reports, or direct to the dentists when such a laboratory service is not available. It must be remembered that the registry cannot act as a diagnostic center in competition with local pathologists, and reports should be requested only when diagnoses cannot be made locally. The registry is prepared to take such cases and to circulate those of special interest among a group of qualified consultants, giving the contributing pathologist or dentist the opinion of this group. Interesting material may be sent to the registry when no diagnosis is necessary, to be included in its files as prospective study material. This is earnestly suggested.

A clinical history, microscopic description and histologic material of each case is filed in the registry for future refer-

From the Dental Section, Army Medical Museum.

*Captain, D. C., U. S. Army.

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ence and use of the profession. When roentgenograms accompany the case, copies are made and the originals returned if requested.

To date, the Registry of Dental and Oral Pathology has 632 cases in its files. This represents a substantial increase over the last report, in 1936. Paul E. Boyle and Rudolf Kronfeld have been particularly diligent in their support, and their interest accounts for many of the recent additions to the files and to the loan study sets.

The 632 cases now on file include:

Carcinoma (all types)	201
Sarcoma (all types)	19
Angioma (all types)	19
Cysts	
Adamantinoma	13
Dentigerous	10
Radicular	65
Mucous (retention)	21
Papilloma	29
Leukoplakia	22
Fibroma (all types)	73
Pyorrhea alveolaris	18
Miscellaneous*	142
Total	632

In order that the maximum of value may be realized from the material accumulated, loan study sets are now being made which will be available for the use of individuals, smaller societies, teachers and students. A comprehensive selection of oral tumors and other lesions will be included so that the user may review his knowledge of these conditions.

The second, and indeed equally important, phase of the registry activity is that of research. It is obvious that much valuable information will result from the study of large numbers of cases and that, as the number of cases on record increases, the value of the registry as a source of statistical information will be enhanced.

The majority of the cases now listed in the registry have been taken from the museum files. It is sincerely hoped that, as a result of this appeal to the dental profession, there will be a greater proportion of cases from other sources.

It is necessary that the profession thoroughly understand that the registry belongs to organized dentistry, to be developed and utilized. It is only through such an understanding that we can hope to gain the support necessary for the proper functioning of this enterprise. If individuals, study groups and dental schools contribute to the registry, it will undoubtedly develop into a source of valuable information.

To be of value to the registry, tissues sent must be accompanied by an accurate and thorough clinical history. The lack of sufficient data in the past has resulted in the discarding of many otherwise interesting specimens. It is well to remember, in studying pathologic preparations, that even a most complete history does not afford the advantages enjoyed by the internist, and it is necessary to record at least the name, age and sex of the patient, and the location, duration, clinical characteristics and probable cause of the lesion. A roentgenographic study, together with a brief report of the operation or treatment and response, is desirable, if the intervening time is sufficient to warrant the latter observation.

In cases of suspected or proved malignancy and in those of unusual interest, it is the custom of the registry to make annual requests of the contributor for information as to the existing condition of the patient.

The accompanying chart is an example of a brief but comprehensive history which will greatly increase the value of the specimen.

Of equal importance is the proper care of tissue to be forwarded for histopathologic study. All tissues undergo degeneration immediately on excision, which alters their histologic characteristics. One of the first of the postmortem

*Includes those conditions represented by less than ten cases.

changes is coagulation of protein substances. Fermentation and putrefaction follow. The end-result is total destruction of cellular detail. Tissues fixed soon after removal therefore show a minimum of change. The process of decomposition may be delayed by keeping unfixed tissue at a low temperature.

There are numerous fixing agents, but, for routine work, 10 per cent formalin is the most practical. This solution is prepared simply by mixing 1 part of commercial formalin with 9 parts of distilled water. For thorough fixation, it is essential that the quantity of solution be at least ten times the bulk of the tissue. After fixation, usually from twenty-four to forty-eight hours, the tissue can be removed and wrapped in gauze or cotton saturated with 10 per cent formalin and mailed to the Curator, Army Medical Museum, War Department, Washington, D. C., in a suitable container.

REGISTRY OF DENTAL AND ORAL PATHOLOGY

Name of contributor.....Address.....
Name of patient.....Age..Sex..Race..
Occupation.....Influencing habits.....
Previous medical or surgical history.....
.....
History of present condition.....
..... Duration.....
Appearance before operation.....
Operation....Date....Specimen from.....
X-Ray Findings.....Clinical diagnosis.....
Remarks .....

Nothing has been said in this paper regarding the museum activities proper of the American Dental Association. There are, at this time, about 2,000 items on permanent display as a separate dental exhibit, comprising gross specimens classified under oral anatomy and pathology, old instruments and moulages. These specimens, gathered over a period of seventy-five years, are viewed annually by thousands of visitors to the Army Medical Museum. They have provoked much favorable comment and have promoted general understanding regarding progress in dentistry.

It has been the sole purpose of this paper to arouse interest in the Registry of Dental and Oral Pathology by explaining its activities, and its benefits for the individual and for the profession. At present, with a dental officer on full time duty at the Army Medical Museum, the registry is active and is expanding, and it is our aim to develop it to the point where it will compare favorably with its companions in the American Registry of Pathology. This can be done only with the cooperation and support of the profession.

Today, dentistry is characterized by progressive changes and ideas and recognizes that further advances will result from a concerted effort in the direction of scientific research. Those who, because of their daily routine practice, find no time to engage in research may do their share by contributing to their registry, giving the profession the benefit of their experience and aiding in the attainment of the goal toward which the healing arts are marching, "The alleviation of human suffering."

CHANGES IN THE INCISOR TEETH OF RATS FOLLOWING EXTRACTION OF THE UPPER RIGHT FIRST AND SECOND MOLARS

By SUMTER S. ARNIM, D.D.S., Chicago, Ill.

INTRODUCTION

DURING the course of earlier studies by Anderson *et al.* (1936) of the molar teeth and supporting structures of growing albino rats, certain changes were observed in the incisor teeth that have not been reported. Characteristic alterations in bone and dentin formation occurred in all rats consuming a low-salt ration. (Arnim *et al.*, 1936.) Changes in enamel formation of the incisors related to the low-salt diet were observed in only a few of these animals and were comparatively slight. However, the incisor enamel of rats in which the upper first and second molars were extracted underwent marked change irrespective of diet. Loss of pigment and translucency, hypoplasia and various histologic changes of the enamel organ were observed.

The purpose of this paper is to compare the reaction of the incisors to extraction of the molars with the reaction obtained by other workers employing various injurious agents.

REVIEW OF THE LITERATURE

The delicate response of the incisor tooth of the rat to various alterations in experimental procedure is well illustrated in the literature dealing with this subject.

Fluorosis.—The gross changes described by McCollum (1925) as shortly following the consumption of excess amounts of fluorine were loss by the incisal enamel of its normal pigmentation, translucency and form, accompanied by gross hypoplasia, malocclusion and fracture of the incisors in some instances. The enamel organ was markedly altered in Bethke's rats (1933). Ameloblasts were short or squamous in type and the interpapillary projections were increased in length. There was an increase in thickness of the predentin and accentuation of the incremental lines. The presence of interglobular dentin was observed. The effect of injection as well as of ingestion of fluorine is described by Schour and Smith (1934). They confirm, on the whole, the findings in chronic fluorosis reported by other workers. A series of interruptions in the smooth surface of the enamel epithelium in the forms of foldings or dips extending into the enamel, representing multiple localized arrests in enamel formation at periodic intervals, is considered characteristic of chronic fluorosis by Schour. Aborted enamel formation, proliferation of papillae of the enamel epithelium, elongation and irregularity were observed in injection experiments. The outstanding histologic feature of the effect of fluorine ingestion was a selective action on enamel and the presence of light or disturbed incremental layers in dentin.

A contribution from the Dental Study Unit, Yale University School of Medicine; work done under the direction of B. G. Anderson, Department of Surgery, and Arthur H. Smith, Laboratory of Physiological Chemistry.

Read before the Section on Therapeutics, Pathology and Research at the Midwinter Meeting of the Chicago Dental Society, February 16, 1938.

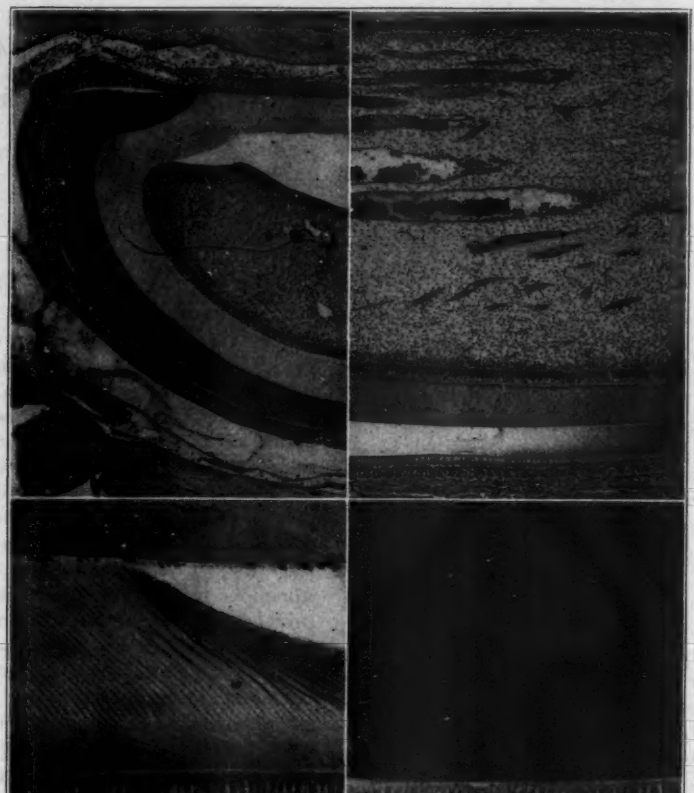

Fig. 1.—A: Mandibular incisor, control, no teeth extracted; tangential section, second molar region. (×40.) B: Mandibular incisor, control, no teeth extracted; tangential section, second molar region. (×40.) C: Basophilic staining bodies along dentino-enamel junction; mandibular incisor, control, no teeth extracted; tangential section, second molar region. (×300.) D: Capillaries in enamel organ; mandibular incisor, control, no teeth extracted; tangential section, molar region. (×300.)

Variations in Mineral Constituencies and Vitamin D.—The influence of addition of inorganic salts and of vitamin D to the diet of rats on the growing incisor has been demonstrated by Bracco (1923), Karshan (1930-1933), Klein (1931), Kronfeld *et al.* (1932), Rosebury *et al.* (1934), Clarke (1935) and others. Changes ranging from irregularities, poor calcification of dentin, atrophy of the

enamel organ and hypoplasia of enamel to proliferation of the cells of the papillary layer of the enamel organ and atypical enamel formation have been reported. Although the analyses of Karshan and of Clarke revealed little change in ash content of the incisor as compared to that in bone, the histologic studies revealed wide variations in the tissue of the incisors. Klein was of the opinion that imbalance in mineral composition of the diet was a significant factor.

Lack of Vitamin A.—The exclusion of vitamin A from the ration of the rat has led to marked changes in the incisor teeth. Smith (1932) reports the loss of normal orange pigment, leaving the incisor dull white and opaque. A decrease in hardness was evidenced by excessive abrasion. The calcium-phosphorus ratio in the deficient incisors was 2.17 as compared to 1.86 in the controls. Realimentation led to complete recovery. Shibata (1931) described the histologic changes accompanying this vitamin deficiency. He observed abnormal enamel, dentin and cementum, and enamel organ atrophy. A decrease in phosphorus and calcium, and an increase in water and magnesium were reported. The rate of eruption was retarded. Wolbach and Howe (1925, 1933) have studied extensively the changes following deprivation of vitamin A. The gross changes observed by other authors are corroborated. A detailed description of the histologic changes revealed an initial effect on the enamel organ. The epithelial papillae shrank in size, adjacent connective tissue became less vascular and, after complete loss of ameloblasts, globular formations of calcified material developed rarely in surrounding connective tissue. Atrophy and depolarization of odontoblasts followed enamel organ changes. Localized pulp ossification was seen. The dentin near the formative end became folded or was absent. Aggregations of two types of cells were associated with the late changes. Glandlike clusters of enamel-organ origin and transitional cells, proliferative in type, resembling a stage between mesenchyme and odontoblasts, were found. These formations disappeared with realimentation.

The effect of prolonged chronic vitamin-A deficiency was described by Orten *et al.* (1937). A loss of pigmentation, translucency and contour, with eventual exfoliation of the erupted portion, was observed. The changes began around 50 days of age. Large solid nonsensitive lumps developed in the maxillae. Histologic studies revealed changes similar to those described by other workers. In addition, tumor growths (odontomata) and a few supernumerary incisors were observed in the majority of animals that survived 365 days. The tumors appeared to originate from the pulp and were composed of pulp-like, spindle-shaped embryonic cells. Some of the tumors replaced the entire alveolar bony structures of the upper and lower jaws, extending to and ulcerating through the gingivae. Small groups of squamous epithelial cells, keratinized at times, were distributed throughout the tumors. Groups of cells resembling odontoblasts were present, frequently adjacent to atypical dentin and osteodentinal structures. Imperfect forms of germinal tooth bud structures were found in some of the tumors. The majority of the original incisors were greatly distorted. The ameloblasts were atrophied and metaplasia to squamous epithelium was observed. No changes were observed in the molars.

Parathyroids.—The effects of thyroparathyroidectomy were demonstrated by Jung and Skillen (1929), who found a disorganization of the ameloblasts, proliferation of the outer layer of the enamel organ, poor calcification and irregularity of enamel, a generally normal condition of the dentin as to contour and thickness, areas of undercalcification and overcalcification, atrophy of the odontoblasts and abnormal calcification in areas in the pulp. In rats in which the lower in-

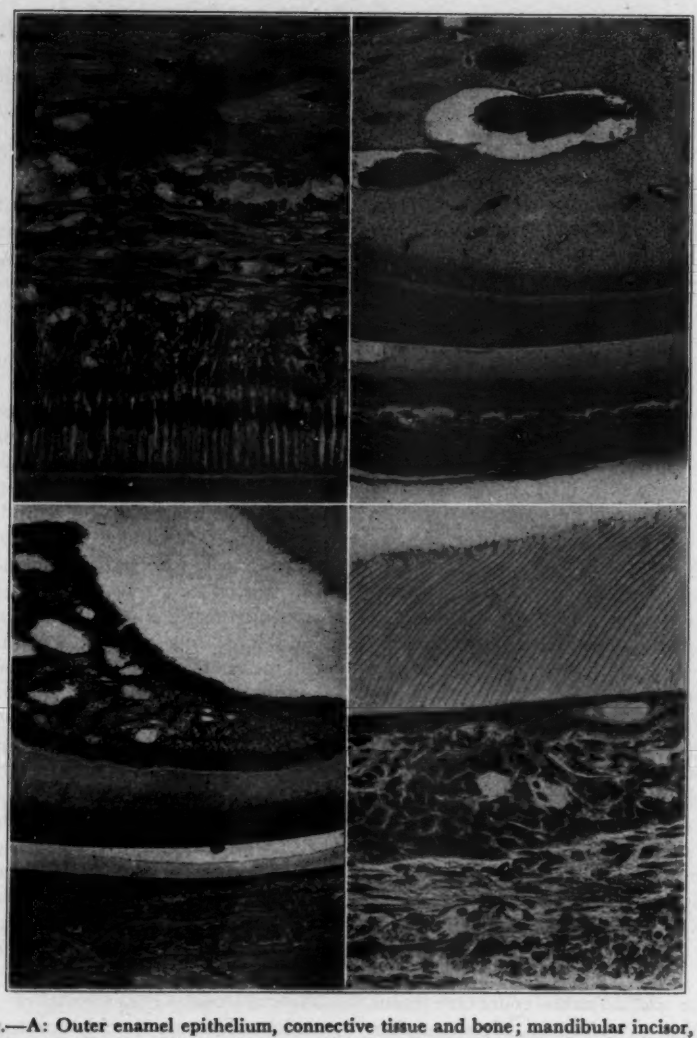

Fig. 2.—A: Outer enamel epithelium, connective tissue and bone; mandibular incisor, control, no teeth extracted; tangential section, second molar region. (×300.) B: Mandibular incisor, low-salt diet, no teeth extracted; tangential section, second molar region. (×40.) C: Wide predentin; mandibular incisor, low-salt diet, no teeth extracted; tangential section, second molar region. (×40.) D: Ameloblast change. (High power magnification [×300] of C.)

cisors were fractured, disorganized masses of enamel epithelium in various stages of proliferation, disarray and atrophy were observed. In the opinion of these authors, their findings do not differ from those of Erdheim (1906, 1911) or Toyofuku (1911).

The effect of single and multiple doses of parathyroid hormone (Schour *et al.*, 1934) on the rat incisor resulted in

enamel hypoplasia, and a disturbance in dentin calcification. A hypocalcified stripe was formed by dentin that was being calcified as an immediate effect of the first injection, and a hypercalcified stripe in the dentin calcified subsequently.

Hypophysectomy.—Changes in the rat incisor following hypophysectomy are described by Schour and Van Dyke (1932). The rate of eruption was retarded and eruption finally ceased. Form was altered by a disturbance of growth of alveolar bone. Enamel hypoplasia and excessive formation due to accumulation with lack of wear were observed. In late stages, enamel organ papillae proliferated, forming irregular cords and islands in adjacent connective tissue. Little or no epithelium lined the enamel space. The dentin was increased in amount and well-calcified and the dentinoid border was normal. The cementum was thickened and the pericementum narrowed. The normally rich blood supply of the pulp, pericementum and alveolar pericementum was markedly reduced. Replacement therapy in the form of administration of a growth-promoting hormone to the hypophysectomized animal increased the eruption rate of incisors when the hormone was not administered too late.

Trauma.—While studying the mode of repair and regeneration of formative cells of rat lower incisors injured by fracture or by the surgical needle, Schour (1934) observed interesting changes in the uninjured upper as well as the lower teeth. The exposed surfaces of the injured teeth showed varying stages of discoloration. The pigment of the uninjured teeth was undisturbed. These teeth were elongated. An increase in size of the protuberance at the posterior end of the fractured incisors was observed with increase in length of life postoperatively. Distortion and accumulation of calcified tissues in the posterior zone were found. Elongation of the uninjured upper teeth, disturbance in contour of the labial surface and formation of areas of hypoplasia were observed. Retardation of eruption was evident in all injured teeth within a week, progressing rapidly, until eruption finally ceased. The degree of retardation was greater as a rule in the uninjured teeth.

The histopathologic findings revealed varying degrees of inflammatory reaction at the seat of fracture. Splinters of bone, dentin and cementum were scattered in this region. Proliferative epithelial rests were calcified in some instances. Cysts were also observed. The anterior part of the pulp was necrotic, whereas the posterior part was partly obliterated by calcification. The posterior fragment revealed varying degrees of accumulation and distortion of calcified dental tissues. Some cartilage was seen in the bone. Incomplete enamel calcification persisted throughout long postoperative life. The normal covering of enamel epithelium was replaced, in many instances, by connective tissue or cementum. Posteriorly, enamel epithelium was atrophied or degenerated. Several areas of hypoplasia were observed. Folding and thickening of the calcified tissues of the labial surface occurred. Large enamel globules were formed in enamel epithelium. Hertwig's sheath was found functional in all cases.

Premature atrophy of enamel epithelium was the most constant finding in uninjured teeth. Enamel hypoplasia was common, and dentin hypoplasia was observed in some instances. Connective tissue and bone replaced missing enamel epithelium.

Schour offered the hypothesis that the primary factor in these changes was the release by the injured cells of specific substances that entered the blood stream, influencing distant homologous cells.

METHODS

A synthetic diet, adequate except for extreme restriction of inorganic salts to certain animals, was fed 147 rats (Anderson *et al.*, 1936). The animals consum-

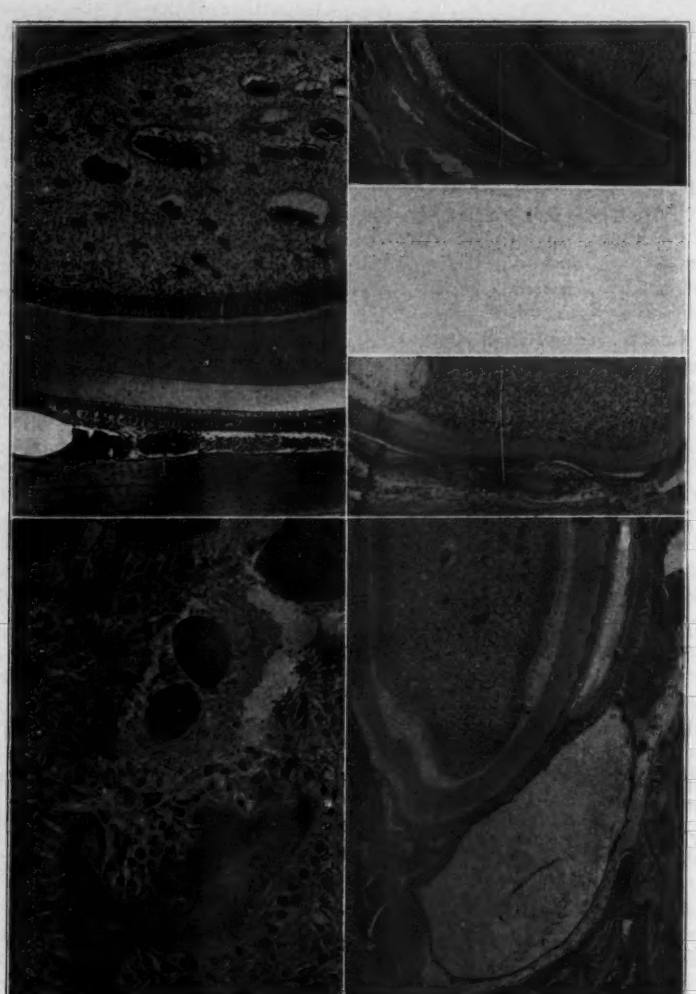

Fig. 3.—A: Mandibular incisor, low-salt diet, realimented twelve weeks, no teeth extracted; tangential section, second molar region. (×40.) B: Mandibular incisor, adequate diet, teeth extracted; tangential section, second molar region. (×40.) C: Enamel hypoplasia; mandibular incisor, low-salt diet, teeth extracted; tangential section, second molar region. (×40.) D: Atypical enamel formation; mandibular incisor, low-salt diet, teeth extracted; tangential section, second molar region. (×300.) E: Enamel organ cyst; mandibular incisor, low-salt diet, teeth extracted; tangential section, second molar region. (×40.)

ing the low-salt diet were divided into three groups. The first (nineteen rats) were killed after twelve weeks' feeding; the second (forty-four rats) were realimented for four, eight and twelve weeks with an adequate diet, and the third (twenty-seven rats) had the upper right first and second molars extracted at

23 days of age. The fifty-seven control rats received an adequate supply of mineral salts in addition to the purified foodstuffs throughout the experimental period. One group (twenty-seven rats) had the upper right first and second molars extracted at 23 days of age. The age of the rats used in this study varied from 70 to 193 days. Measurements were made of individual structures on animals approximately 123 days old.

HISTOLOGIC DESCRIPTION OF CONTROLS (NO TEETH EXTRACTED)

Lingual Bone.—The mandibular incisor of the rats in the region of the lower second and third molars was separated from the molar roots by cancellous bone. The marrow was vascular and markedly cellular. Megakaryocytes were relatively conspicuous. Few adipose tissue cells were seen. Cancellous lamellae extended from the compact alveolar wall adjacent to the pericementum, into the marrow spaces. Blood vessels and nerves passed through the alveolar wall from the bone marrow to the pericementum. Occasional groups of resorption lacunae, containing multinucleated giant cells in some instances, were seen on the alveolar wall. Numerous osteoblasts were observed along the bony surfaces. (Fig. 1A.)

Pericementum.—The pericementum along the superior border of the incisor was composed of cellular fibrous connective tissue, fairly even in thickness. The nuclei were oval, large and vesicular, with their long axes parallel to the course of the fibers. The fibers had a slight distal inclination from the bone toward the tooth. Numerous blood vessels and occasional nerves divided the fibers of the pericementum adjacent to the alveolar wall into bundles. That half of the pericementum adjacent to the tooth was comparatively avascular and formed a dense homogeneous membrane. (Fig. 1A.)

Cementum.—The cuboidal cells adjacent to the cementum contained large vesicular round or ovoid nuclei. The cementum was thin; even in thickness, approximately 1.8 microns, and acellular. (Fig. 1A.)

Dentin.—The dentin was composed of the dentinal tubules and their contents within an apparently homogeneous matrix. The tubules were straight and extended from the pulp to the cementum. A thin regular layer of predentin, approximately 5-10 microns in width, bordered the pulpal surface. No secondary dentin was seen. (Fig. 1A.)

Pulp.—The pulp was composed of a loose vascular fibrous connective tissue. The cells had large vesicular nuclei and numerous protoplasmic processes. They were embedded in an intercellular substance containing a fine loose network of fibrils. Along the border of the pulp, there was a regular dense zone of odontoblasts approximately 45 microns wide, with long oval nuclei in a palisade arrangement. Cytoplasmic processes could be seen extending from these cells into the dentinal tubules. Blood vessels were observed in this zone, but none extended beyond it into the dentin. (Fig. 1B.)

Enamel.—The space, about 1 mm. in width, formerly occupied by enamel was outlined by the dentino-enamel surface and the enamel organ. In sections decalcified in 5 per cent nitric acid, enamel remains filled the enamel space from the apical portion anteriorly to the second molar region. Numerous basophilic staining irregularly ovoid bodies were observed in the enamel remains closely adherent to the dentin. In that portion of the enamel space where the enamel was destroyed completely by the acid, the small bodies were easily observed, apparently attached to the dentin by thin fibrillar processes. (Fig. 1C.) Processes also extended into the enamel remains. Outlines of the enamel rods were plainly seen in the inner three-fourths of the enamel remains. The outer one-fourth was apparently homogeneous. The ameloblasts

in this area (second molar), 36 to 45 microns long and 2.5 to 4 microns wide, were arranged very regularly at right angles to the enamel and parallel to one another. They were separated in some instances from the enamel remains by a thin irregular band of fibrillar material. The cell membrane was difficult to observe, irregular and hazy. The cytoplasm was faintly granular, comparatively translucent near the nuclei and more opaque near the enamel. The nuclei were long (5.4 to 9 microns), oval and vesicular. The outer enamel epithelium formed an irregular band of approximately 50 to 60 microns in width adjoining the ameloblasts. The edge adjacent to the connective tissue was scalloped. No connective tissue extended deeply into the band-forming true papillae in this area. The appearance was more glandlike than papillary. Many small capillaries were seen among the epithelial cells. None extended into the ameloblastic layer. (Figs. 1C and D and 2A.)

Separating the outer enamel epithelium from the dense noncancellated cortical bone forming the border of the mandible was a layer of highly vascular connective tissue. The cells were arranged parallel to the long axis of the tooth. The nuclei were more deeply stained, longer, thinner and less vesicular than those in the connective tissue on the molar side of the incisor. Osteoblasts and resorption lacunae were comparatively scarce along the bony surface. (Fig. 2A.)

LOW-SALT GROUP (NO TEETH EXTRACTED)

Changes in the Incisor Teeth.—No differences were observed in the gross appearance of the incisors of the low-salt group of rats with no teeth extracted or in the controls. Certain histologic changes were observed in all the low-salt group of rats. The changes found in the investing tissues have been previously described. (Arnim *et al.*, 1936.)

The predentinal layer was wide and irregular. It varied in width from 20 to 40 microns. Vessels traversing the odontoblastic zone were easily seen, giving it a slightly vacuolated appearance. There was no significant change in the width of this zone. No differences were observed in the enamel thickness or the cementum. (Fig. 2B.) Separating the ameloblasts from the enamel remains in many instances was an irregular band stippled with minute basophilic particles and very fine fibrils. The ameloblasts were frequently separated by clear ovoid spaces, giving the layer a vacuolated appearance. (Fig. 2B.) In a few animals, the slight changes just described were greatly exaggerated. The predentinal layer attained a width of 135 microns. The width of the enamel remains was approximately the same as that of the controls. The ameloblasts were no longer columnar, but ovoid, and the outer enamel epithelium varied tremendously in thickness and was partly separated in some cases from the ameloblastic layer by connective tissue. (Fig. 2C and D.)

No significant differences were observed between the incisors of the animals realimented for four, eight or twelve weeks and the controls. (Fig. 3A.)

CONTROLS AND LOW SALT (TEETH EXTRACTED)

Gross Description.—Certain changes were observed in the appearance of all the incisors of these rats at necropsy that were not observed in any of the intact animals. The incisors of thirteen of the rats consuming the adequate diet with molars extracted had definitely lost their normal translucency and were gray. An equal number of the low-salt group of animals were similarly affected. The lower incisors of four of the low-salt group of rats fractured spontaneously before they reached the age at which the animals were killed.

Histologic Description.—Certain histologic changes were observed in the in-

cisors of the rats in which the molars were extracted that were not seen in any of the intact animals. These changes were not so marked in the group consuming the adequate ration as in those observed in the low-salt group. They were limited in occurrence to the enamel organ in the rats on the adequate diet. The ameloblasts were frequently separated from the enamel remains by an irregular vacuolated band of fibrillar material containing basophilic globules of varying sizes. In several instances, the ameloblastic layer was folded and irregular, and, at times, two layers were present. (Fig. 3B.) The outer enamel epithelium was comparatively narrow (18 microns in width) and the adjacent connective tissue was comparatively avascular.

LOW-SALT GROUP (TEETH EXTRACTED)

There were in the incisors and supporting structures of the low-salt group of rats in which the molars were extracted changes characteristic of animals on this ration. In addition, teeth were observed in which the enamel organs had undergone marked atrophy. (Fig. 3C.) The enamel remains were extremely variable in width. The ameloblasts were missing in some regions and very short in others. The width of the outer enamel epithelium varied greatly. Atypical dentin and enamel formation were observed. (Fig. 3D.) In one instance, a cavity lined with squamous epithelium and containing a very fine fibrillar network replaced a portion of the enamel organ. (Fig. 3E.)

COMMENT

The changes in the enamel organs of the rat incisors following the extraction of the upper first and second molars were so unexpected and so startling that they naturally led to some speculation as to the manner of their occurrence. The literature dealing with enamel organ changes is divided principally into two types.

The tissue appears to respond to injury in two ways: (1) atrophy followed by loss of part of the organ, resulting in enamel hypoplasia, and (2) abnormal proliferation in localized areas, resulting in atypical enamel formation. Both responses are frequently encountered in one incisor. They appear to be readily elicited by various experimental procedures. A review of the literature reveals that the presence of abnormal amounts of fluorine in the ration leads to loss of pigment, gross hypoplasia, atrophy of the ameloblasts, proliferation of papillae and aborted enamel formation. Similar findings differing in intensity, character and localization are observed with variations in mineral and vitamin constituencies of the diet. Parathyroidectomy and hypophysectomy result in like changes. Fracture of the lower incisors led to related changes in the uninjured upper teeth, and extraction of the upper first and second molars at 23 days of age reveals a similar picture. Although the histologic changes following the various forms of injury cited are easily related to the specific agent employed, the problem arises: At just what time does the effect of the injurious agent become overshadowed by the sequelae?

Schour's (1934) hypothesis that mechanical injury to the cells of the enamel organ led to the release of a specific substance into the blood stream affecting distant homologous cells might explain the changes in the incisors of the rats in which the molars were extracted. Cells of the enamel organ of the forming third molar may have been injured by the extraction of the first and second molars. The possibility that avitaminosis, fluorosis and other injuries may lead to an eventual release of the same substance must be considered. The effect of these experimental procedures on the balance of occlusal forces may be a factor. The secondary effects of retarded eruption,

accidental fracture of incisors and disturbed molar occlusion must be taken into consideration.

SUMMARY

A study of the incisor teeth of five groups of growing albino rats, control, low-salt, realimented, low salt with teeth extracted and control with teeth extracted, revealed certain characteristic changes in bone and dentin formation related to the consumption of the low-salt ration. After extraction of the upper right first and second molars, the enamel of the incisors underwent marked alterations. Loss of pigment, loss of translucency, hypoplasia, atrophy and proliferative changes in the enamel organ were observed.

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HEAT TREATMENT OF DENTAL GOLD ALLOYS

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MANY operators neglect to heat treat platinum-palladium gold alloys, and hence do not take full advantage of the remarkable properties of these alloys. This is unfortunate in view of the fact that the heat treatments required to soften these alloys for easy adjustment, or to harden them for proper strength, are very simple and require little time.

This article is written with the hope that a better understanding of the principles of heat treatment will lead more operators to profit by its use.

Thoroughly annealed and quenched platinum-palladium gold alloys are relatively soft and ductile, and, when examined under the microscope, are seen to possess a homogeneous structure. However, if these alloys are reheated to appropriate (low) temperatures, or allowed to cool slowly, some of the component metals react with each other to form very small particles of a new phase which greatly strengthens the alloys. It is this characteristic which forms the basis of hardening by heat treatment.

The amount of the hardening phase precipitated and the size of the particles formed can be changed by altering the reheating temperature or the rate of cooling, and this changes the hardness and other mechanical properties. These effects are considered and are illustrated herein.

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DENTAL ALLOYS SUSCEPTIBLE TO HEAT TREATMENT

All metals are hardened by cold working and softened by annealing. For example, the softer high gold alloys, such as 22-kt. plate and inlay casting gold, are hardened and strengthened by hammering, swaging, bending or otherwise working, and this work hardness can be removed by annealing at red heat. Certain alloys, such as the platinum-palladium golds, can be hardened by suitable heat treatment as well as by cold working. These platinum-palladium golds are sold as high strength wrought wires, or as all-purpose casting golds for use in partial and full dentures, bars, clasps, saddles, three-quarter crowns, etc., subject to stress.

SOFTENING HEAT TREATMENT

If a cast denture alloy is heated to a temperature in the neighborhood of 1300° F., held there for a short while and then quenched in water at room temperature, its microstructure will appear similar to that shown in Figure 1. This structure is that of a homogeneous solid solution, but the dendritic (pine tree) solidification of the metal obscures the finer details of the structure. This

dendritic formation is not present in wrought alloys as it is removed by working and annealing. Since the fine structure of the platinum-palladium golds is much easier to observe in wrought than in cast alloys, the later photomicrographs presented will be of wrought alloys.

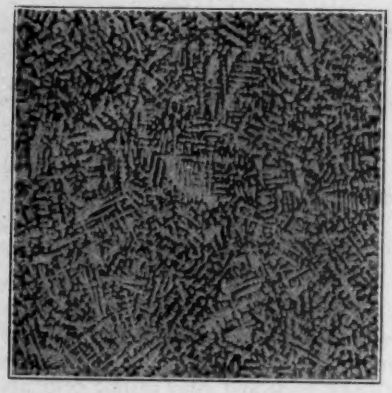

Fig. 1.—Cast structure of dental alloy. (×100.)

Fig. 2 (No. 6306).—Microstructure of dental alloy quenched from 1300° F. (×100.)

It should be emphasized, however, that the changes which occur in cast alloys are similar to those occurring in wrought alloys, although they are usually more difficult to see because of the dendritic crystallization developed on solidification.

Figure 2 is a photomicrograph of a wrought platinum-palladium gold alloy having a composition similar to that used for high strength castings, after annealing at 1300° F. and quenching in water. The dendritic crystallization has been eliminated by working, and all that can be seen is a large number of grains of uniform composition. This structure is technically known as a solid solution structure in that all components are in a

Fig. 3 (No. 6295).—Microstructure of wrought dental alloy quenched from 1300° F. (×500.)

Fig. 4 (No. 6293).—Microstructure of wrought dental alloy quenched from 1650° F. (×500.)

solution which happens to be solid rather than liquid. When in this state, the platinum-palladium golds are relatively soft and ductile.

For the cast dental alloys, annealing at temperatures in the neighborhood of 1300° F. and quenching in water usually bring all components into solution, yielding relatively soft and ductile alloys. For wrought alloys, it is generally desirable to leave some at the excess phase undissolved to retain a fibrous structure, as shown in Figure 3. To develop this desirable structure, the composition is designed so that the alloys become sufficiently ductile, but all the excess phase does not go completely into solution at

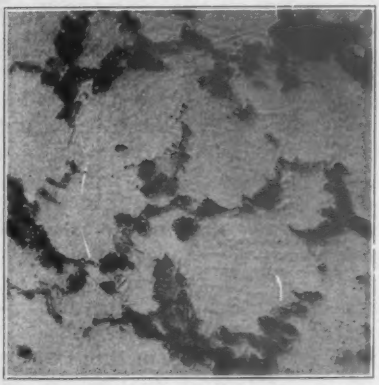

Fig. 5 (No. 6310).—Microstructure of dental alloy heat treated at 842° F. for 100 hours. (×125.)

normal annealing temperatures of about 1300° F. High softening temperatures should not be used for these alloys as this destroys the fibrous structure, as shown in Figure 4, and, if they are subsequently hardened, some brittleness may result.

HARDENING HEAT TREATMENT

The softened platinum-palladium golds contain more of the excess phase than they desire to hold in solution, but the high viscosity at low temperatures prevents the atoms from diffusing and precipitating, so that, at room temperature, these alloys will remain in this soft condition indefinitely. However, if the temperature is raised to between 400° and 1000° F., the atoms acquire sufficient mobility to combine and form particles of a new phase. This new phase, which hardens and strengthens the alloy, is indicated in the dark constituent in Figure 5, a photomicrograph of the alloy shown in Figure 2 after softening and heat-treating at 842° F. for 100 hours.

This long heat treatment is required to form particles of sufficient size to be readily seen under the microscope. Precipitation and hardening will also occur within the temperature range 400-1000°

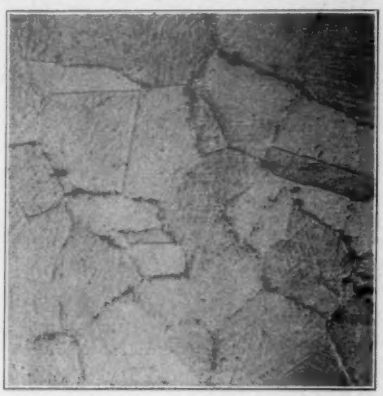

Fig. 6 (No. 6344).—Microstructure of dental alloy slowly cooled from 1475° F. in 105 hours. (×125.)

F., if the alloy is cooled from some higher temperature, the amount of precipitate and the size of the particles depending on the time the alloy is at temperatures within the hardening range. It is because of this that it is necessary to quench or rapidly cool alloys from the annealing temperature to maintain the soft solid solution.

Figure 6 shows the precipitate obtained in the alloy shown in Figure 2 after very slow cooling from 1475° F. in 105 hours. Air cooling of small sections usually al-

lows insufficient time for precipitation and leaves alloys in a reasonably soft state, but marked precipitation leading to brittleness may occur in large castings allowed to cool in the flask.

Close examination of the photomicrographs in Figures 5 and 6 reveals considerable precipitation at the grain boundaries, which greatly reduces the ductility. To minimize this reduction in ductility, it is advisable to stop the hardening heat treatment when the alloy is only partly hardened and before all the excess phase is precipitated. For most dental alloys, hardening heat treatments of less than thirty minutes give adequate

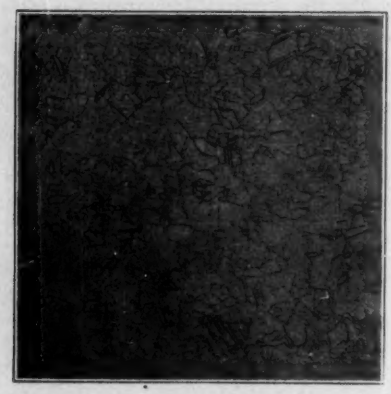

Fig. 7 (No. 6332).—Microstructure of dental alloy after oven cooling from 842° F. to 482° F. in thirty minutes. (×50.)

increase in strength with suitable ductility. Figure 7 is a photomicrograph of the alloy shown in Figure 2 after oven cooling from 842° to 482° F. in thirty minutes. Although this alloy hardened considerably on heat treatment, the precipitate is in such fine form that it is invisible at ordinary magnifications.

For most platinum-palladium golds, marked hardening will occur at temperatures between about 450° F. and 900° F., depending on the composition. Below 450° F., the high viscosity prevents appreciable precipitation; above 900° F., the precipitate starts to go back into solution. These effects are shown in Figure 8, which is a curve showing the effect of heat-treating temperature on the mechanical properties of a dental alloy originally quenched from 1300° F. For this particular alloy, only slight precipitation and hardening occur at 450° F., higher temperatures (between 600° and 700° F.) being required to obtain the maximum proportional limit for the fifteen-minute heat treatment employed. At higher temperatures, the precipitate starts to go back into solution, and it is completely dissolved at about 1100° F. Once all the precipitate is dissolved, the alloy is soft and ductile and can be rehardened by slow cooling or reheating within the hardening range.

The mechanical properties of an oven-cooled sample (842° to 482° F. in thirty minutes) are also included in Figure 8 for comparison. It will be noted that the ductility (elongation) decreases as the strength increases and that the ductility of the alloys aged at constant temperature is higher than that of the oven-cooled alloy. Generally, better ductility can be secured by heat-treating at a constant temperature rather than oven cooling, but manufacturers should be consulted to obtain the most suitable time and temperature for heat-treating their specific alloy compositions.

AVOIDING INADVERTENT HARDENING AND SOFTENING

It will be seen from the foregoing that the hardening and softening processes are as simple in mechanism as in practice. Heating to a temperature in the neighborhood of 1300° F. and rapidly cooling dissolves most of the excess phase and leaves these alloys relatively soft and ductile. Heating to temperatures within the hardening range, or slowly cooling, precipitates the excess phase and leaves the alloys stronger, but less ductile.

These processes take place each time

the alloy is heated and cooled, and care should be taken to avoid inadvertent hardening or softening. Heating to the soldering temperature will of course offset any previous hardening, and attachments other than the one being soldered may be heated to the hardening temperature and hardened. For this reason, it is generally advisable to soften the entire restoration after soldering and then reharden. This insures uniform and proper hardness to all parts. Care should also be taken in softening and soldering wrought wires, as high temperature treatments might dissolve all the excess phase and destroy the fibrous structure. When these overheated alloys are given the normal hardening heat treatment, considerable excess phase precipitates at the grain boundaries, and this leads to brittleness.

Some casting alloys are so composed as to harden to full strength on cooling in the flask, but if any adjustments are to be made, such castings should be softened by heating and quenching prior to bending operations, and subsequently hardened by reheating

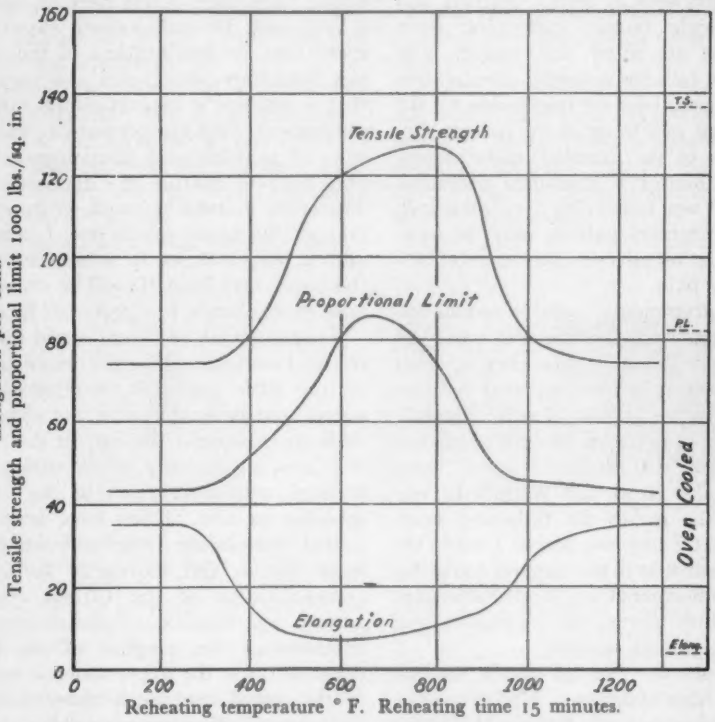

Fig. 8.—Effect of reheating temperature on the mechanical properties of a dental alloy originally quenched from 1300° F.

It is hoped that this discussion may clarify the nature of the hardening and softening processes so that the dentist and technician can take full advantage of the platinum-palladium gold alloys.

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REFERRED PAIN FROM UNERUPTED TEETH

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PATIENTS suffering from neuralgic pains of the face and head are frequently seen in dental practice, and the etiologic factors underlying these conditions are many and varied. The syndrome calls for a careful investigation by all persons who are responsible for the health and well-being of the patient. Cooperation of the internist, otolaryngologist and dentist is absolutely necessary, for if but one fails in his appointed task, the unfortunate patient may be condemned to months or even years of unnecessary pain.

Not uncommonly, painful stimuli applied in one branch of the fifth nerve are manifested in other branches of that nerve, or even in areas supplied by other cranial nerves. John Finch Barnhill, anatomist of note, has recently published an excellent text on the "Surgical Anatomy of the Head and Neck." In one chapter, he makes the following statement: "At a previous period I made the observation that if the surgeon could but successfully combat the painful affections of the fifth nerve, his reputation and fortune would be assured."

Certainly we can all vouch for the truth of that statement. Unfortunately, no one has as yet solved the riddle of the fifth nerve, with its wide distribution and complex communications with other cranial nerves and with the sympathetic system. Having become hopelessly involved in an effort to learn a little more about the fifth nerve and its communications, I sought the aid of E. Vernon Hahn, of Indianapolis, a neurosurgeon whose knowledge of the nervous system is profound. His only answer was to the effect that the ramifications of the various nerves are so complex and variable that to attempt to explain all the various phenomena from our present-day knowledge of anatomy and physiology would only tend to confuse the diagnostician. Therefore, to dwell at length on the anatomy of the nerve would not, I believe, add in any manner to whatever value this paper may have. It will be necessary only to mention a few pertinent facts.

Painful stimuli of dental origin can be referred anywhere along the continuation of the fifth nerve or communicating nerves and be manifest in the opposite arch, in or around the ear, in the mastoid area, on the scalp, in the parietal or occiptal regions or even in the neck, shoulder or arm. Cases have been reported wherein the disturbance was even more remote, and because of the intercommunication of the various cranial nerves, and because of the downward extension of the ganglion of the fifth nerve as far as the upper thoracic region of the spinal cord, such manifestations are anatomically comprehensible.

In some instances, when pain is felt in some part or organ at some distance from the area receiving the irritating stimulus, but innervated by the same or related nerves, the principle stated by Henry Head may afford us the best explanation: "When a painful stimulus is applied to a part of low sensibility in close central connection with a part of much greater sensibility the pain produced is felt in

Read before the Section on Therapeutics, Pathology and Research at the Seventy-Fourth Annual Midwinter Meeting of the Chicago Dental Society, February 17, 1938.

the part of higher sensibility rather than in the part of lower sensibility to which the stimulus was actually applied." This fact must be constantly kept in mind in our dealings with patients.

For the purpose of this paper, cases of neuralgia can be grouped as follows:

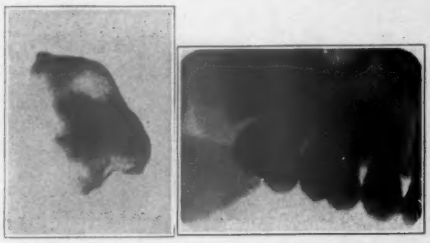
1. Those wherein pain is manifested in or around the teeth as a result of disturbances elsewhere in the head. A classic example is the feeling of soreness and elongation of the teeth resulting from sinus infection.

2. Those wherein pain is manifested in the mandible, but the painful stimulus is in the maxillae, or vice versa.

3. Those wherein the neuralgia is of dental origin, but the pain is referred elsewhere in the head.

The first and second types of neuralgia will not be considered in this paper.

Fig. 1.—Lower third molar, showing root grooved for mandibular nerve. There was a history of earache for fourteen weeks, with no local signs or symptoms. The patient was afforded immediate and permanent relief on the removal of the lower third molar.



A B

Fig. 2.—Resorption of distal surface of root of second molar from pressure of third molar. There was a history of earache for several months preceding the removal of the second and third molars. There has been no recurrence.

There are many possible causes for neuralgia of the third type mentioned, including dental caries, periodontal disease, the presence of impacted teeth, infected third molar flaps, cysts, split teeth, degenerating pulps and postoperative disturbances following the extraction of teeth. The majority of cases of this type are fairly easy to diagnose for the reason that there are usually local signs and symptoms to aid in the diagnosis.

There are other cases, however, wherein local signs and symptoms are either entirely lacking or are so slight as to go unnoticed by both patient and dentist. Completely unerupted teeth which do not communicate with the mouth in any manner occasionally are responsible for this type of neuralgia. This disturbance may be produced in one of two ways: (1) the development of a tooth in close approximation to a nerve trunk or (2) the presence of an unerupted tooth, causing resorption of the roots of adjacent teeth.

The manifestations which the individual patient may have are endless. However, so many patients describe their sufferings similarly that there is, we believe, a place in dental literature for the following syndrome.

The patient usually gives a history of neuralgic pain of long standing. We have seen patients who have endured these pains for years. The most common complaint is of pain in or around the ear. There is a reasonable explanation of this since the auriculotemporal branch of the fifth nerve innervates the auditory meatus as well as the tympanic membrane. Many patients also complain of flashes of pain, beginning deep in the face and projected horizontally backward to the occipital region. This region

is innervated by the greater and lesser occipital nerves, which arise from the second and third segments of the cervical part of the spinal cord. This would best be explained by the previously mentioned downward prolongation of the trigeminal nucleus.

As earache is an almost ever-present symptom, that organ is first examined. The otolaryngologist, finding nothing wrong in that region, immediately suspects the sphenopalatine ganglion. Sinus infection occasionally produces the so-called sphenopalatine syndrome, one of the manifestations of which is pain in the ear. Since almost every one in this part of the country has some sinus infection, treatment of the sinuses is the next step. Surprisingly enough, the patient is often temporarily relieved of the pain, but in time, it returns, and the patient seeks another physician. Finally, dental consultation is sought, not because there are mouth symptoms, but because every other means of curing the patient has been exhausted. In a series of cases of this type, unerupted teeth have been found to be the cause. This condition is most commonly overlooked when the upper third molar is impacted high on the distal surface of the second molar roots and in no way communicating with the mouth. Roentgenographically, the tooth usually appears to be on the buccal or lingual side of the second molar root. However, close scrutiny of the x-ray film will often fail to show one or more of the roots of the second molar. This is always a difficult thing to demonstrate roentgenographically. In some cases, we have been uncertain of the diagnosis and have removed the third molar and then examined the second molar clinically before removing it. In several cases, entire roots have been resorbed, or one side of a root, with exposure of the pulp.

The presence of any unerupted tooth can cause this condition, but, in our series of cases, upper third molars have been the chief offenders. Occasionally, the presence of a lower third molar with the roots grooved for the canal has caused this type of neuralgia without apparent local manifestations. In all probability, there is a low-grade inflammatory process in the follicular space, not sufficient to cause local pain, but severe enough to cause a painful stimulation of the mandibular nerve.

A B

Fig. 3.—Resorption of distal surface of distobuccal root of upper second molar (A), from pressure of third molar exposing pulp canal. There was a history of severe pain in the ear and mastoid area for two months. Pain ceased when a local anesthetic was administered. There was no recurrence after removal of the second and third molars.

A B

Fig. 4.—(A) Second and third molars and (B) upper second molar showing resorption of distobuccal root of the second molar. There was a history of severe pain of four years' duration. The case had been diagnosed as sphenopalatine neuralgia. All symptoms subsided when the upper second and third molars were removed.

A small percentage of patients complaining of neuralgic pains are true neurotics who will, of course, not benefit from any dental treatment. However, many patients classed as neurotics have a definite complaint. Certainly, every patient should receive the benefit of an exhaustive examination before the mouth is ruled out as a source of nerve irritation.

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PRINCIPLES AND PRACTICAL APPLICATION INVOLVED IN THE SURVEY AND DESIGN FOR PARTIAL DENTURES

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THE term "survey and design" as applied to partial dentures here means the study and preparation of a master model for the construction of a casting model. Study consists in finding the peculiarities of that master model. The first effort is to determine what surfaces of the remaining teeth would hinder or prevent placement of a partial denture. We must know what surfaces are to be used for retaining the denture. We should plan what type clasp is best suited to the conditions found, ascertaining the amount of retention to be used. We should protect every clasp tooth against overload and unnecessary leverage forces. The original position of clasp teeth must be maintained. Settling of the case must be prevented to assure long life for the clasp teeth. A proper dental model survey and application will overcome many of the disadvantages formerly so discouraging to dentists and patients.

ADVANCE OF DENTAL MODEL SURVEY

A few years ago, little was said about surveying. Today, not many would attempt the construction of a partial denture without some form of survey. It is accepted as being positively necessary. Some are satisfied by simply scribing a carbon line showing the greatest circumference of the teeth for clasp position. Proper survey goes much farther, taking into consideration the case as a unit, placing all retentive and reciprocal clasp wings in definite relationship to each other. We may change the position of the master model to modify undesirable undercuts and may manipulate into the case increased or decreased retention as the common vertical plane indicates.

In designing a partial denture, we must take into consideration many things: placement, retention, path of insertion, stabilization, leverage and comfort, and must guard against tooth movement. To overlook any of these necessary points will ultimately result in failure or, at least, a short life for the case.

Practically all the information I have to offer has been gained through an intensive study of practical cases, noting success or failure. When the subject is understood, few cases will be found that cannot be handled satisfactorily. Patients should not be advised to sacrifice any

Read before the Section on Partial Denture Prosthesis at the Seventy-Ninth Annual Session of the American Dental Association, Atlantic City, N. J., July 14, 1937.

healthy teeth or teeth that can be placed in a state of health.

TOOTH CROWN ANATOMY

The partial denture is intended to be a splint to aid remaining teeth in their proper function. It is intended to perform the function of the missing teeth. Normal anatomic tooth crown form suggests locations upon their surfaces favorable to clasp retention. These surfaces are the vertical angles. The retaining points are fairly constant if considered on individual teeth and without regard for other teeth which are to bear clasps. Many times the missing teeth have been absent for years, with resultant drifting of the remaining teeth in the general direction of their normal inclinations. Such drifting places the remaining teeth in many non-parallel planes in relation to their long axis, and normal retaining vertical angles may become non-retaining from a common vertical plane.

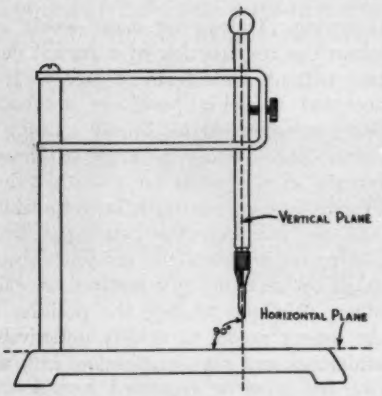

Fig. 1.—Two planes, one horizontal or base; the other, a vertical or working tool. By means of having the vertical plane, mounted on a swinging support and a movable base placed on the horizontal plane on which to mount a master model, it is possible, by manipulation, to find a common vertical plane best suited to all the conditions found on that master model. All undesirable undercuts that would prevent a finished casting from going into position may be eliminated or scribed out. Retentive areas may be located and measured and the degree of retention that should be used be decided.

When hand design is employed, each clasp is made to spring over its tooth independently of every other clasp tooth.

The conditions found on teeth which have drifted extensively cause confusion as to just where the clasp wings should be placed, and much space must be provided around the mesial and distal surfaces, with the result that distressing food traps are formed.

Vertical type survey and design may eliminate many of these otherwise open spaces. The master model may be manipulated and retention be placed on any tooth surface thought most suitable for the case. Vertical survey does not require that one and only one position be found for design. Many different

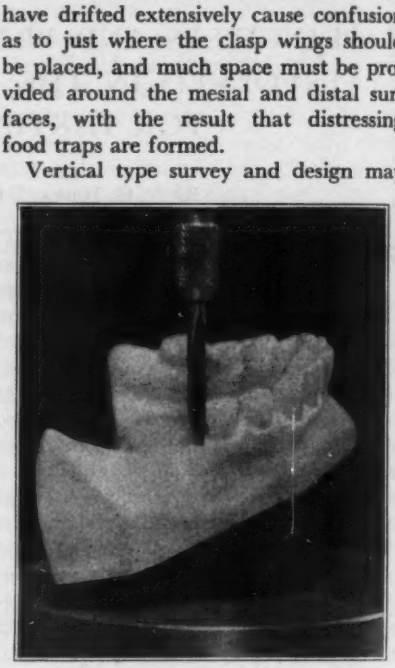

Fig. 2.—Master model mounted on movable base and held in position by semiplastic material. By this method, any point on the master model in contact with the semiplastic mounting material may become a pivotal point and is not restricted to one point only. This is important for coarse and fine adjustment for finding the most suitable common vertical plane.

positions are possible, each having its advantages. It is through study that we may overcome many of the disadvantages usually found in the master model.

In the survey design, we are able, at every stage of the proceeding, to tell, in advance, what the result is going to be and we do not have to wait for completion of the case to find out what has happened.

To attempt to visualize all the unusual conditions, the abnormal positions of the teeth, irregular surfaces, distant locations and relationships, is more than the human mind or eye can accomplish. To coordinate all these conflicting conditions, and

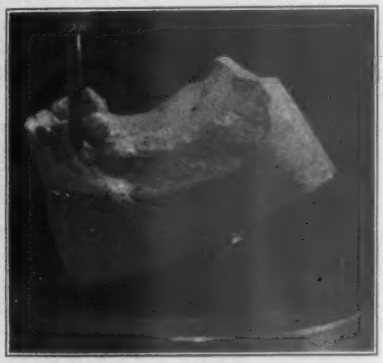

Fig. 3.—Master model in correct position to provide retention on mesial surface of first upper right bicuspid. Retention here is obtained wholly through manipulation of master model. The same type of retention is provided on the same surface of the left first bicuspid. By the use of a continuous bar on the lingual surfaces of the anterior teeth, the clasp wings to be provided furnish both retention and stabilization for the casting. From a hand design, this case will require clasp wings under pressure for retention. Two former attempts were failures. The position shown will be the path of insertion for the finished casting.

to simplify design, it becomes necessary to use an instrument. (Fig. 1.)

UNIT CONSTRUCTION

Unit construction requires that all clasps be designed from one common vertical plane. To do this, a base, to be known as a horizontal plane, is provided and a working tool is established at right angles to the base, to be known as a vertical plane. (Fig. 2.) Means are provided for a master model to be placed upon a movable base and brought into relationship with the working tools. Means are also provided for unrestricted movement of the master model so that different positions may be assumed in its relation to the vertical plane of the instrument.

Fig. 4.—Master model in an arbitrary position upon the movable base of the instrument. At this point, the relation or degree of the angles of desirable and undesirable undercuts in relation to each other is not known. To determine this, the master model must be placed in relation to the vertical working tool of the instrument. Many tooth surfaces where vertical angles are thought to be retentive, from a horizontal position, are not.

In the preliminary survey, we are confronted with two problems, seating the case and retaining it when seated. Because of the anatomic form of the tooth crown and the inclined positions which the teeth assume, we must consider constricted undercut surfaces as

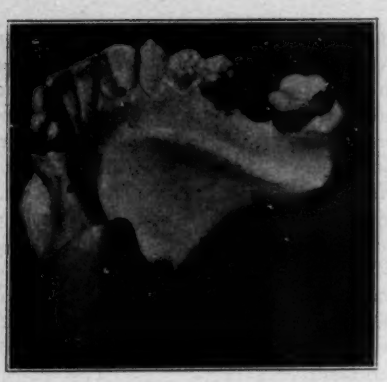

Fig. 5.—Master model on which the undesirable undercuts have been filled in with undercut material and surplus material has been removed. The dark areas around the teeth are the undercut material. This master model is ready for duplication in a casting model. The casting model will have no undesirable undercuts on it, which eliminates much time in finishing and fitting the case. The retaining points are definitely known.

first objective to find means to overcome the undesirable undercuts found on the master model. Our next objective is to find desirable undercuts that may be used to retain the case in position. Both these objectives may be found through manipulation of the instrument.

We know that these undesirable and desirable undercut surfaces vary in degree and in relation to each other. In a survey of the vertical type, we are able to see and study these relationships and manipulate the position of the master model accordingly. (Fig. 3.) Although many of the cases present teeth whose surfaces or positions are favorable to retention, we find almost an equal number the surfaces of which are not favorable to retention. And again the instrument comes into use, and with it scientific retention can be obtained.

In the actual process of design and survey, the master model is placed upon

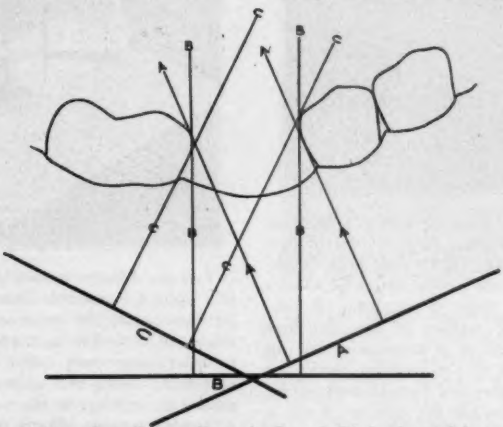

Fig. 6.—Diagram representing (heavy lines A, B and C) horizontal base of instrument and vertical planes (light lines A, B and C) in relation to horizontal planes or bases. By changing the position of the master model on the plastic mounting material on the instrument, undercuts can be increased or decreased or compromised. Each change in position is under direct visible control.

undesirable for placement of a partial denture or desirable if used for its retention.

Before we can retain a case, we must place it in position, and so it becomes our

the instrument in an approximately horizontal position, teeth upward. The tool is placed against each of the involved teeth in turn. Where the vertical side of the working tool touches the tooth marks

the greatest circumference or diameter of that tooth in that position. In some cases, below this point is an undercut area, sometimes favorable for retention, but in other cases unfavorable and preventing placement. (Fig. 5.) In placing the vertical tool against the mesial or distal surfaces, extreme undesirable undercuts may be found on some teeth, whereas less or none may be found on others. By tilting the master model on the semiplastic base, adjustments may be made to eliminate undesirable undercuts until the most favorable position is found. (Fig. 6.) At the same time, observation can be made to locate undercuts favorable to retention. Actually, by tilting the master model, we are changing the path of insertion.

Fig. 7.—Registration of master model on instrument of desired common plane which is path of insertion. The three ink dots are located as far apart as possible. These dots are all equally distant from the main base or horizontal plane of the instrument. They will be transferred to the casting model in duplication in order that the casting model may be retripoded on the instrument for carbon marking, to refresh the memory as to the location of retaining undercuts and to show the amount of undercut to be used in the waxing of the clasps.

REGISTRATION OF MASTER MODEL POSITION

As soon as the desired position of a master model is found, its position is registered. By loosening the surveying spindle and using a cone-shaped working tool, three widely separated locations are found on the master model, all equally distant from the main base and each registered by means of an ink dot. This is called tripoding the master model. (Fig. 7.)

At this stage of construction, our next purpose is to eliminate all undesirable undercuts. This is done by filling in all undesirable undercuts with undercut material and, with a vertical working tool on the instrument, scribing away the excess material, thereby placing all undesirable undercut surfaces in one com-

Fig. 8.—Treatment of master model, which is first well soaked in water to remove all air. Hydrocolloid material is reduced to a thin consistency by the addition of water. It is boiled until all lumps are reduced. The temperature is then reduced to about 130° before pouring. This solution is poured over the wet master model mounted in a flask for the purpose. Before the hydrocolloid material is poured, the three ink dots on the master model are touched with an indelible lead which will register on hydrocolloid material. Their locations in hydrocolloid are again touched with indelible lead before the pouring in investment. The three dots will then be shown on the casting model for use in retripoding.

mon plane with the working tool of the instrument. The result is clearly shown in Figure 5.

The prepared master model is then duplicated in hydrocolloid material. (Fig. 8.)

The ink dots placed on the master model are transferred to the casting model, which permits this model to be placed upon the instrument in the exact position occupied by the master model. The carbon tool is then used to scribe on the teeth to be clasped carbon lines showing the greatest circumference, and used as guides in the placing of wax clasps. When the master model is duplicated in casting investment, the casting

Fig. 9.—Prepared casting model. The model is being retripoded by bringing the three dots in contact with the point of a working tool on the instrument. When properly placed, these points will be equally distant from the base of the instrument and in exactly the same position as was the original master model. The carbon lines for clasp tip positions can then be placed as originally planned for retention of the case.

model will have no undercuts except those predetermined as retentive. (Fig. 9.)

Let us attempt to visualize what retention is. It is a triangle in form and the degree or angle of retention is determined by the base of the triangle. The vertical side of the surveying tool becomes one side of the triangle; the surface of the tooth becomes the other. If the undercut surface of the tooth is placed in parallel relation to the plane of the instrument, there will be no favorable retention. As the gingival area of the model is moved away from the parallel position, retention increases, and is measured by the triangle base. (Fig. 10.)

CLASP WINGS

There are three types of clasp wings: rigid, semirigid and spring. The rigid type clasp wing is made stronger and will not open or close in placement. It is used to reciprocate with an undercut clasp wing which is retentive. The semirigid clasp wing will allow very slight spring and its use is restricted to limited undercut areas. If there is too much re-

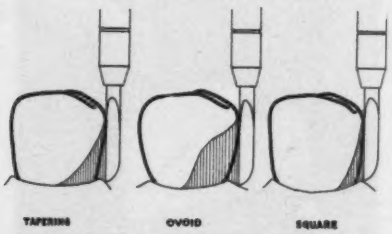

Fig. 10.—Diagrammatic explanation of retention. The retentive area on any tooth is shaped similarly to a triangle, one side of which must be a vertical plane, true if the instrument is used, or imagined by comparison. The other side need not be so and its shape will be according to the type or position of the tooth in relation to the vertical plane. Through manipulation, the base of the triangle may be increased or decreased in its length and the degree of retention thus be measured. In the same manner, retention may be *manipulated* and measured on a tooth surface if a triangle space can be provided between the true vertical plane of the instrument and any tooth surface on which retention is desired, provided such manipulation of the master model does not cause undesirable and excessive undercuts on other clasp teeth involved in the case, in that common plane.

tention, the clasp will not go to position. The spring type are long delicate wings that open and close readily. Their

origin is at the strap or body portion and they engage the teeth on the buccal, labial and lingual surfaces. The length of the clasp wing and the size determines its flexibility.

CLASSIFICATION OF CLASPS

The general classifications of clasps and their types are as follows: circumferential, bar, diagonal and continuous. Surveyed clasps may be true or modified types in three of the general classifications.

Circumferential clasps are in most general use. They are simple and easily fitted. They are suggested when the undercut area is found to be distant from the saddle area. They engage most of the exposed tooth circumferences, reaching to the vertical angles for retention.

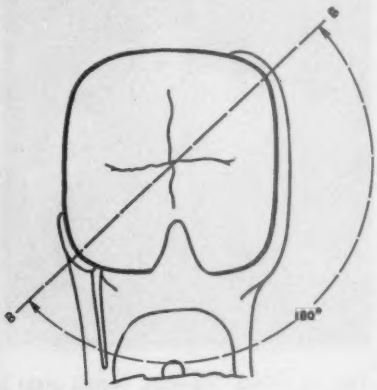

Fig. 11.—Diagram showing that all clasps, regardless of their type, must engage at some points more than one-half circumference of tooth, to protect tooth against force applied against inclined plane of occlusal rest. The only exception to this rule applies in the case of a precision attachment being used, and, as a rule, at least one clasp wing is desirable. If protection is not given the clasp tooth, it will move. Retention and reciprocal points will change and the case will settle.

Bar clasps vary and are named according to the letter of the alphabet that they resemble. They are indicated where the undercut used is near the saddle area. In hand design, their retentive wings usually detour from the saddle to approach an undercut at a vertical angle on the tooth. The modified bar, without detour, is a fine clasp and should be used frequently where indicated. The retentive point of the bar type clasp is definitely located in vertical surveying as well as reciprocation for its undercut. (Fig. 11.) All clasps of any type must engage more than 180 degrees of the tooth crown circumference. If not so protected, the

Fig. 12.—Final position chosen for this case. The vertical working tool is placed at the point that retention was manipulated into the case; namely, the distolabiovertical angle of the upper right cuspid. The same type of retention was used on the corresponding left cuspid. Dark areas can be seen on the distal surfaces of the right and left cuspids and the distal and a portion of the buccal surface of the right second bicuspid. These dark areas, which are undercut material, will represent space which will be present between the tooth surfaces and the finished casting. The casting must be placed in position from the vertical angle shown. The mesial surface of the second bicuspid will prevent the case from insertion at any other angle. The second bicuspid could be removed, and the retention will not be disturbed. The strength of the cuspid clasps and a continuous clasp on the lingual surfaces of all anterior teeth will assure ample support for this case.

tooth will move, losing its retentive and reciprocal locations, and settling of the case will occur. Settling is of sufficient importance to require special consideration.

The diagonal clasp has its origin near the occlusal rest or near the point angle of the tooth on the surface near the saddle, and passes over the area of convexity in the gingival direction. It is placed diagonally across the buccal or labial surfaces of the teeth. It is a very rigid clasp and must be used with caution to prevent use of too much undercut. It is an excellent clasp and its use is suggested in unusual retentive areas. It is used as a stabilizer as well as for retention.

The continuous clasp is really not a clasp, but the term is descriptive, as it usually connects two clasp wings. It is used on the lingual surfaces of the upper and lower teeth, and is a stabilizer. Its use will allow reduction in the size of the lingual or palatal bars and will per-

Fig. 13.—Case showing retention only on lingual surfaces of right and left second bicuspids. The lower right and left bicuspids are inclined lingually in such a manner that, from a hand design or a position truly horizontal to the occlusal surface, the lingual bar would stand away from the tissue almost one-eighth inch on each side. From a horizontal position, the lingual clasp wings and lingual bar would have to be made so weak that they would spring into place and have much exposed or open space. From the position shown, which is the path of insertion, the lingual bar may be placed directly upon the lingual tissues (without any space) and retention is provided at the mesiobuccal and mesiolingual vertical angles of the second bicuspid teeth, and a firm rigid case constructed. Spaces will be created at the mesial surfaces of the third molars, where least objectionable. Should these molar teeth be absent, there would be no open food traps at any place where casting and teeth or tissues contact.

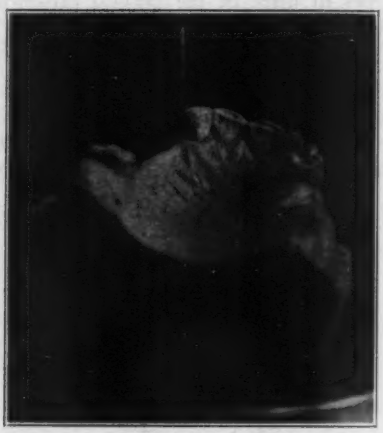

Fig. 14.—Case "favoring" upper right lateral incisor; that is, avoiding pressure on this tooth. The master model is placed in a plane with the distal surface of the tooth, and the path of insertion is placed as shown. Such a position is unfavorable to the upper right molar and left first bicuspid. The casting cannot be made to encroach on the gingivolingual surface of the molar by one-quarter inch. The vertical carbon tool will indicate how close an approach can be made to still insert the case. The retentive undercut in the position shown comes at the distobuccal vertical angle on the left bicuspid. Retention must then be provided by a bar-type clasp. Retention is also provided by a T-bar on the lingual surface of the second molar. Stability and balance are provided by a continuous clasp on the lingual surfaces of all the anterior teeth. A finger is placed at the distolabiovertical angle of the right lateral incisor, but no undercut is used. A palatal bar strengthens the case by a completed circle. This has proved a successful procedure and is simple if the rules of vertical type surveying are known.

mit the teeth in contact to carry some of the load of mastication. It is considered quite necessary in extension saddle cases, especially those cases in which only two clasps may be used.

In the vertical type survey, the type clasp to be used is suggested by the position of the master model in relation to the vertical plane of the instrument. Undercut retention, if distant from the saddle, suggests the circumferential or diagonal clasp. An undercut area near the saddle suggests a bar type clasp wing.

RELATIONSHIP OF RETENTION AND RECIPROCAL CLASP WINGS

One of the high points of dental model surveying design is the fact that all retentive and reciprocal clasp wings are determined in relation to each other. It is possible, even in a large case, to use only one or two retentive wings, and all other clasp wings may be reciprocal.

Before the advent of surveying, stabilization caused dentists much concern. In order to seat a denture with individually designed clasps, wings were made quite flexible. This type of construction will allow a clasp to engage a tooth from practically any vertical direction. But the weakness of the clasp wings will not prevent lateral motion unless they are stabilized by a palatal or lingual bar. In our early experience with one-piece castings, unilateral cases were not thought successful unless the case carried very wide clasp wings.

In the proper use of the surveyed design, castings may approach fixed bridges in stability in both unilateral and bilateral types. This is accomplished by means of unit construction and proper use of definitely known retentive and reciprocal areas. The clasp wings are made more rigid and will prevent lateral movement.

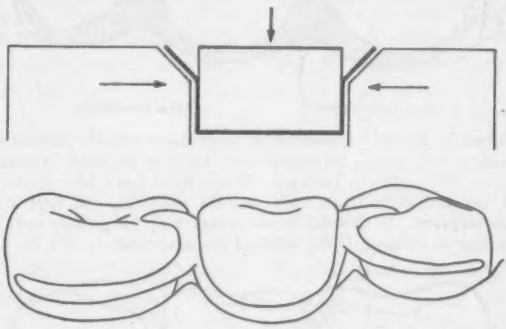

Fig. 15.—Diagram presenting common cause of case settling, which involves more serious trouble than any one thing in partial denture design. If clasp wings are made long and weak, they cannot overcome the force exerted against the inclined planes of the occlusal rests on the teeth, and constant readjustments are necessary to even keep the cases in position. The teeth under constant strain move away from the body of the clasp. As the prosthesis settles, the lingual and palatal bars embed themselves in the tissues, and prosthesis and teeth are lost much too soon. In former procedure, space was usually provided under the base, anticipating settling. Proper knowledge of unit construction in surveyed design overcomes practically all cases of settling and assures longer life. In unit survey and design, palatal and lingual bars are placed on the tissues without relief.

If individual teeth are forced to carry more than a fair share of the load of mastication, soreness, and later looseness, will result and they may be quickly lost. All bilateral castings must have four points of support and, if possible, at least three of these points should be fixed.

In extension saddle cases, it is possible

to stabilize partial dentures against lift by strengthening the labial or buccal wings of the clasp. We depend on tuberosity and retromolar regions to support the extension saddle areas. Little dependence can be placed on tissue support against settling. Extension saddles should be carried posteriorly as far as is practical to gain needed support.

There is much discussion on this point, but, in many cases, we must use all available support regardless of our desire. We should guard against overweight and imbalance, and if cases are extremely large, the weight may be lessened by skeleton construction.

placement and likewise easy removal and requires maximum retention. In many cases, there is not sufficient retentive area to retain the denture and the case will result in failure or be classed as impossible. So-called difficult cases, those lacking visible retention, have had much to do in causing dentists to advise against this type of restoration and have been the cause of much needless extraction. (Fig. 13.)

In the surveyed design, the path of insertion can be seen when the master model is in position on the instrument, but is lost when removed. The patient soon finds the angle which will allow the case to go to position. It should be the rule to finally *place* the master model during study of design in a position other than horizontal to the occlusal surfaces. The greater the inclination of the master model, the less the retention needed. In use, the normal release of the case is vertical to the occlusal surface. If the path of insertion is other than the true

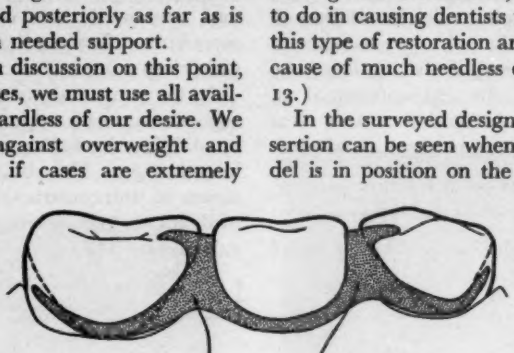

Fig. 16.—Case shown in Figure 15, indicating open space usually present at mesial and distal surfaces between casting and teeth. In square type teeth or in teeth in nearly normal position, these spaces are not so noticeable to patients. When teeth have been absent for a long period of time, there is a decided drift from their normal positions. In such cases, the food trap area is distressing to patients. If desired, these spaces may be greatly reduced in size through compromise, or they can be bridged, if the method is understood.

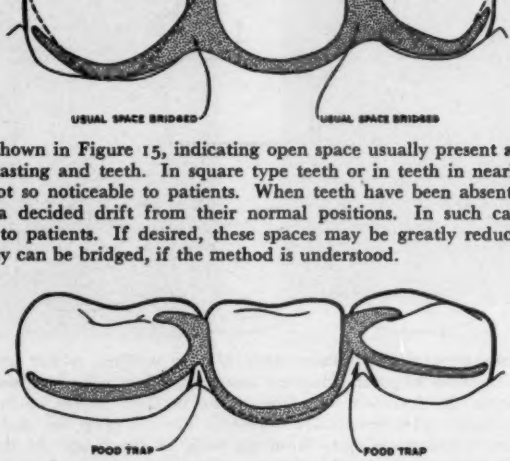

Fig. 17.—Widening of body of clasp buccolingually, strengthening of clasp wings, reduction of retentive undercut and bridging of food trap area will prevent settling. The teeth are protected against movement.

PATH OF INSERTION

All partial dentures have a definite path of insertion. (Fig. 12.) Whatever that path is the patient soon finds it. In hand design, the path of insertion and of removal is practically always vertical to the horizontal plane of the occlusal surfaces of the teeth. This results in easy

vertical, tooth surfaces become resistant to release and play almost as important a part in retention as do the undercuts. (Fig. 14.) In many cases, tilted or weak teeth are favored; that is, their heavily inclined surfaces or extreme undercuts are placed in plane or parallel with the working tool of the instrument. This allows the case to be inserted in a line parallel to the inclined tooth surfaces, and become retentive when in use.

It is one thing to place a casting in the mouth easily and for it to be comfortable for a time, but it is quite another thing to keep it that way. Teeth move because of continued pressure exerted against the inclined planes of the occlusal rests or unequal pressure on clasp wings or because unsupported through weak spring type clasp wings and lack of sufficient circumferential engagement.

SETTLING

One of the most common causes of failure in partial dentures has been the movement of the remaining teeth, resulting in settling of the denture.

Most of our occlusal rests are prepared as an inclined plane of nearly 45 degrees with the long axis of the teeth for comparison. (Fig. 15.)

Direct masticatory pressure against these inclined planes of the occlusal rests has a tendency to force the teeth away from the clasp body. The action is similar to that of a wedge. (Fig. 16.) If spring type clasps are used, their weakness allows the clasp wings to open under pressure and the occlusal rests travel downward in a mesial or distal direction, as the case may be. The teeth are forced away from their original positions, losing retentive and reciprocal contact, and the case settles. (Fig. 17.)

In the survey technic using rigid and semirigid clasp wings, this settling, with its resultant destruction of teeth and supporting tissues, is prevented. Bars, lingual and palatal, may be placed directly on the tissues without relief, and thereby the food-accumulating spaces usually present be prevented.

Patients will not tolerate soreness, unrelieved pressure, large bulk, food-accumulating spaces, restricted movement of the frenal tissue or many of the small annoyances, greatly magnified in the mouth. To be satisfied, a patient must be unconscious of the presence of a denture. If intelligent use is made of the method described, many former disadvantages may be overcome.

CLINICAL MEDICINE IN DENTAL EDUCATION

By JOHN BELL WILLIAMS, Ph.G., D.D.S., Richmond, Va.

DENTAL education is about to pass its one hundredth birthday, and soon another hundred years will lie stretched out before us. Shall we toss the future into the lap of chance and trust that in the slow process of evolution gains will be made? Or shall we set goals, stake out the field, and with new ideals, new hopes and new confidence make comprehensive plans for another century? One plan certainly deserves our most earnest attention, and let this plan be my theme—my text if you will—the teaching of clinical medicine to dental students.

The laws of nature demand that every living thing either grow or decay. Therefore, this paper also may be called a *quo vadis* of medicodental education, since we hope to raise the question of whether we shall encourage our medicodental relationship to grow or, contented with what has been accomplished, rest comfortably where we are and thus let decay set in. For my part, I see an excellent opportunity for future achievement in this momentous movement, which is bound to come sooner or later. Two roads lie before us: On the one hand, we can intelligently plan to expedite the forward movement; on the other, we can lazily muddle along and let some future generation promote the forward movement.

THE PRESENT SITUATION

Because dentistry is an integral part of medical centers, and because a working relationship has been established between many private physicians and dentists, it is logical to presume that medical students now receive adequate instruction regarding dental diseases and dental students adequate training in clinical medicine. A true picture of the situation, however, may be seen by reviewing typical schedules of classes attended by students of both schools. Tables 1, 2, 4 and 5 present verbatim schedules of classes published by typical dental and medical schools for the year 1937-1938. This picture presents a strange paradox, so strange as to be almost unbelievable.

PRELIMINARY EDUCATIONAL REQUIREMENTS

Generally speaking, the educational requirements for admission to medical schools are three years of collegiate work. In dental schools, applicants for admission must have completed two years of college study. Both schools include biology, chemistry and physics in their entrance requirements.

THE FRESHMAN YEAR

In the freshman year of the average dental and medical school, as shown in Table 1, both medical and dental students complete courses in anatomy, histology and embryology. In addition, the medical students study bacteriology, biochemistry and psychobiology and the dental curriculum includes art, analytic and organic chemistry and personal hygiene. Dental students also begin to develop finger dexterity through prosthetic procedures. (Table 1.)

Read before the Piedmont Dental Society, Lynchburg, Va., September 25, 1938.

THE SOPHOMORE YEAR

In the second year, both groups cover pathology, pharmacology and physiology. In the medical school, the study of medicine is started, together with physical diagnosis, public health and surgery. Here the dental curriculum brings in biochemistry, bacteriology and general pathology, and includes three technical courses: prosthetic dentistry, crown and bridge work and operative dentistry. (Table 2.)

Thus both medical and dental students have now studied biology, chemistry, physics, biochemistry, anatomy, histology, embryology, bacteriology, general pathology, pharmacology, physiology and introductory courses to their respective clinical fields. (Table 3.)

THE JUNIOR YEAR

At this point, we find that medical and dental students have reached a parting of the ways. They meet again only after each has found from the school of experience that it is to the interest of his patients for the two professions to work together; for, in the third year, the medical curriculum includes 1,040 hours of clinical medicine and only eight hours of dentistry, while the dental curriculum of 1,180 hours is devoted entirely to dentistry except for sixteen hours in first aid. (Table 4.)

THE SENIOR YEAR

The division of subjects noted in the third year is continued into the fourth, where no dental subjects are taught in

TABLE 1.—SUBJECTS COVERED BY FRESHMAN MEDICAL AND DENTAL STUDENTS

Medicine	Hours	Dentistry	Hours
Anatomy, gross	330	Anatomy, gross	288
Anatomy, neural	96	Anatomy, oral (human)	128
Histology	169	Anatomy, oral (comparative)	16
Embryology	108	Art	64
Bacteriology	144	Chemistry, analytic	80
Biochemistry	244	Chemistry, organic	112
Psychobiology	16	Histology and embryology	176
		Personal hygiene	16
		Prosthetic dentistry	160
	Total, 1,087		Total, 1,034

TABLE 2.—SUBJECTS COVERED BY SECOND YEAR MEDICAL AND DENTAL STUDENTS

Medicine	Hours	Dentistry	Hours
Medicine	32	Bacteriology	96
Clinical pathology	64	Biochemistry	112
Physical diagnosis	64	Crown and bridge work	192
Parasitology	48	Operative dentistry	176
Pathology	297	Pathology, general	112
Pharmacology	144	Pharmacology	64
Physiology	256	Physiology	144
Psychopathology	16	Prosthetic dentistry	192
Public health	48		
Surgery, including fractures	32		
	Total, 1,000		Total, 1,088

the medical school, and but forty-eight hours of clinical medicine is included in the dental curriculum. (Table 5.)

during their junior and senior years studying clinical dentistry, with only forty-eight hours given to systemic dis-

TABLE 3.—SUBJECTS COVERED BY END OF SOPHOMORE YEAR BY BOTH MEDICAL AND DENTAL STUDENTS TOGETHER WITH INTRODUCTORY COURSES TO THEIR RESPECTIVE CLINICAL FIELDS

Medicine		Dentistry	
Biology		Biology	
Physics		Physics	
Chemistry		Chemistry	
Biochemistry		Biochemistry	
Anatomy		Anatomy	
Histology		Histology	
Embryology		Embryology	
Bacteriology		Bacteriology	
General pathology		General pathology	
Pharmacology		Pharmacology	
Physiology		Physiology	
Introductory subjects to clinical medicine		Introductory subjects to clinical dentistry	
	Hours		Hours
Medicine	32	Prosthetic dentistry	352
Physical diagnosis	64	Operative dentistry	176
Public health	48	Crown and bridge work	192
Surgery	32		

TABLE 4.—SUBJECTS COVERED BY JUNIOR MEDICAL AND DENTAL STUDENTS

Medicine	Hours	Dentistry	Hours
Dentistry	8	Clinic	668
Dermatology and syphilology	80	Crown and bridge work	160
Gynecology	40	Exodontia and anesthesia	32
Medicine	328	First aid	16
Clinical pathology	48	Metallurgy	16
Medical jurisprudence	16	Operative dentistry	16
Physical diagnosis	56	Pathology and therapeutics, oral	160
History of medicine	16	Prosthetic dentistry	96
Neuropsychiatry	48	Radiology	16
Obstetrics	80		
Ophthalmology	8		
Otolarnygology	32		
Pediatrics	80		
Radiology	32		
Surgery, general	128		
Surgery, urologic	16		
Surgery, neurologic	16		
Surgery, orthopedic	16		
	Total, 1,048		Total, 1,180

THE PARADOX

By applying simple mathematics to Tables 4 and 5, we find that dental students spend approximately 2,000 hours

ease; whereas medical students spend approximately 2,000 hours during the same period in studying clinical medicine, with only eight hours devoted to dental

disease. To put it in figures again: If it takes 2,000 hours to teach clinical dentistry to dental students and 2,000 hours to teach clinical medicine to medical students, it is obvious that dental students can no more learn the rudiments of each special branch of medical practice in a total of forty-eight hours than medical students can learn the fundamentals of dentistry in eight.

From our profession's viewpoint, we know that a continuation of detailed technical instruction in dental subjects is essential to dental education. At the same time, we believe that the dentist must have a clear conception of the relationship of his work to the general health of his patients, else his service is that of a technician rather than that of a scientist.

We do not desire to destroy the autonomy of our profession. We do not propose the creation of two types of dental practitioners, mechanical and scientific. We are not suggesting that dentists be groomed to attempt the practice of medicine nor that physicians practice dentistry. We do believe, however, that every dentist should know enough medicine to recognize the indications for referring patients to physicians, and every physician should know enough dentistry to recognize indications for referring patients to dentists. We also believe that both physicians and dentists should be qualified to join in consultations with a broad understanding of the reasons for all points of view.

We must realize that every well-balanced plan of dental education should train men to treat oral disease in its relation to the body as a whole, and that this cannot be done unless they can recognize diseases of the whole body. We further know that our present system of dental education teaches all of the fundamental sciences and basic medical subjects necessary to accomplish these purposes. Why, with all this foundation carefully laid, should the builder stop, leaving to each occupant the building of his own superstructure? Is it logical not to go on? It is quite clear that the two professions need a working relationship. It also is quite clear that as teachers of future physicians and dentists, we seem to recognize this future relationship not at all. We actually give to each the same basic instruction and then add but an inkling of the other's real field of activity. Yet we expect understanding, sympathy and enthusiastic cooperation suddenly to

TABLE 5.—SUBJECTS COVERED BY SENIOR MEDICAL AND DENTAL STUDENTS

Medicine	Hours	Dentistry	Hours
Medicine	264	Clinic	752
Neuropsychiatry	63	Clinical practice	32
Obstetrics	156	Crown and bridge work	16
Ophthalmology	36	Exodontia and anesthesia	16
Pediatrics	132	Operative dentistry	16
Preventive medicine	48	Orthodontia	96
Radiology	16	Periodontia	16
Surgery, general	240	Principles of medicine	48
Surgery, urologic	56	Principles of practice	32
Surgery, neurologic	16	Prosthetic dentistry	16
Surgery, orthopedic	40	Radiology	16
Gynecology	32	Surgery, oral	64
Electives	..		
	Total, 1,099		Total, 1,120

burst into flower once each is handed his diploma. Could a more paradoxical picture ever be found?

REPORT OF THE CURRICULUM SURVEY COMMITTEE

Consulting the 1935 report of the Curriculum Survey Committee of the American Association of Dental Schools, we find that of thirty-nine dental schools of America, only one devotes as much as ninety-nine hours to medicine; whereas one requires sixty-four hours; twenty-one require about thirty-two hours and fourteen less than thirty-two hours and one requires sixteen hours and one twelve hours. (Table 6.)

TABLE 6.—AVERAGE NUMBER OF HOURS DEVOTED TO CLINICAL MEDICINE IN AMERICAN DENTAL SCHOOLS IN 1935*

Number of Schools	Hours per School	Total Hours
1	99	99
1	64	64
21	32	672
14	30	420
1	16	16
1	12	12
Total, 39		Total, 1,283
	Average, 32.89 hours	

*As published by the Curriculum Survey Committee of the American Association of Dental Schools.

A SOLUTION

A solution to this situation seems to lie in the establishment of medicodental clinics in teaching hospitals and medical clinics, such clinics to be used for the diagnosis and treatment of conditions in which dental disease constitutes a part of the general diagnostic study and treatment of medical patients. These clinics would offer excellent opportunities for dental students to obtain a practical grasp of clinical medicine and medical students a working understanding of dental diseases. Naturally, the relation between medical and dental subjects will need to be emphasized. More than that, the dental student must acquire a gen-

TABLE 8.—HOW 300 HOURS CAN BE DIVIDED TO GIVE DENTAL STUDENTS COMPREHENSIVE GRASP OF CLINICAL MEDICINE

	Hours
Dentistry	
Medicine	152
Surgery	32
Physical diagnosis	32
Clinical pathology	24
Ophthalmology and otolaryngology	20
Dermatology and syphilology	8
Psychiatry	8
Radiology, general	8
Pediatrics	8
Public health	8
	Total, 300

TABLE 7.—HOW 300 HOURS MAY BE MADE AVAILABLE FOR TEACHING CLINICAL MEDICINE TO DENTAL STUDENTS WITHOUT DISTURBING PRESENT SCHEDULE OF HOURS AS SHOWN IN TABLES 1, 2, 4 AND 5

	Dentistry Hours	
Organic chemistry	112	Change to predental years*
Personal hygiene	16	Absorb
First aid	16	Absorb
Principles of medicine	48	Absorb
Present clinic†	108	Transfer to new medicodental clinic
	Total, 300	

*With the recent change of predental academic study from one year to two years, ample time is now available for this subject in the predental period.

†Now 62 per cent of all junior and senior hours.

eral understanding of the clinical picture of medical diseases as demonstrated with patients, else he cannot grasp their true relation to his own professional work. To accomplish this, the medical instructors in these medicodental clinics can use medical patients with their complete records and histories to explain general diseases to the dental class. At the same time, the dental instructors in these clinics can illustrate oral diseases to the students of medicine.

It would be tedious and unnecessary to go into too many details relating to this instruction. It must suffice to say here, by way of practical illustration, that if the dental student could see patients with jaundice, diabetes, syphilis, iritis, pernicious anemia, purpura hemorrhagica, etc., and be given a classical description of the clinical and laboratory findings, he would have a better appreciation of the oral changes that they present. By the same reasoning, if the medical student could be shown several types of alveolar abscesses, stomatitis, tooth impactions, mouth tumors, pyorrhea, pulpitis, etc., he would acquire a better understanding of dental conditions involved in his problems. To express it another way, the successive steps according to their urgency appear to be (1) teaching of the etiology, pathology, symptoms and signs, diagnosis, differential diagnosis, prognosis and treatment of those conditions which, though systemic, have oral manifestations requiring active treatment by the dentist; (2) expansion of the scope of instruction along the same lines in those systemic conditions with oral manifestations of which the treatment by the dentist is secondary to and dependent on the progress made in the treatment of the general condition, and (3) with the advances suggested as steps along the road to progress that demand immediate consideration, cultivation of the fields which still lie beyond, to the great enrichment of the dental mind.

This may be called the cultural side of medicodental practice. All this borderland of medicodental problems lies fallow for cultivation by the inquiring mind. It offers a delightful range for exploration. It can divert the mind, while weary backs and legs relax and recover from the strain of the day's routine and the spirit rests from its burden of carrying the patient's ills. As early as it can be done, dental education should point the student to the broader scientific satisfactions that rightfully belong to him in his chosen work.

If the practical ideals herein outlined are to be achieved, textbooks will have to be compiled. There will also have to be rearrangements, readjustments and other changes which will cost time, labor and money. But what real achievement has ever been accomplished without such costs? And is not the end worth it?

Table 7 shows how 300 hours can be taken from the present schedule; Table 8, how these hours can be used to the advantage of the dental student.

CONCLUSIONS

1. Dental students are given all the preparatory training necessary to interpret systemic diseases in relation to their future professional work.

2. The course of instruction for dental students, however, does not adequately cover the subjects of systemic disease.

3. The course of instruction for medical students does not adequately cover the subjects of dental disease.

4. It is proposed that our colleges broaden their instruction in these fields through the establishment of medicodental teaching clinics.

5. The matter of perfecting this instruction will require much earnest thought on the part of broad-minded men not disposed to dogmatize. The outline in the report of the Curriculum Committee of the American Association of Dental Schools, although deficient as far as hours are concerned, is a valuable

basis upon which details can be developed.

6. Since the universities of the country occupy a preeminent position for leadership, the creation of broad well-balanced programs of medicodental education, which more than all else will lead future dentists and physicians toward a real community of interest and understanding, is suggested.

Quo vadis?

1000 West Grace Street.

OBTAINING THE VERTICAL RELATION IN EDENTULOUS CASES THAT EXISTED PRIOR TO EXTRACTION

By M. E. Niswonger, D.D.S., Dayton, Ohio

An explanation of the following terms seems rather necessary to make the contents of this paper coherent. This will be done by quoting from F. M. Hight's article in the August 1936 Journal:

> Tooth relations should not be confused with jaw relations. Central occlusion refers to the harmonious interrelation of opposing teeth. Centric relation is a jaw position. In the construction of either complete or partial dentures in which opposing cuspal relations have been lost, centric jaw relation must be recorded before it is possible to establish central occlusion. Therefore, centric relation indirectly becomes a tooth relation only after the teeth have been arranged in accordance with the recorded centric jaw relation. This statement implies that the two must be in harmony.

Vertical relation, sometimes called vertical dimension, is a convenient term used in referring to the nose and chin relations which are affected by the distance between the jaws. The correct nose and chin relation or correct vertical relation is controlled by the natural or artificial teeth in centric occlusion, or by centric relation when the baseplates are in position.

Vertical relation can be better understood and obtained clinically if one understands the rest position of the mandible. The purpose of this paper is to bring about a better understanding of the vertical relation by explaining the rest position of the mandible. We do not know a great deal about this rest position, and our textbooks and magazine literature tell us little.

The contents of this paper will be presented under three heads: the rest position of the mandible, centric occlusion and the centric relation of mandible to maxillae, and the application of the foregoing to edentulous cases. All are to be studied as applying to mouths having a complement of natural teeth and to those that are edentulous. Part of the material on the rest position of the mandible is repeated from a previous article.[1]

THE REST POSITION OF THE MANDIBLE

The rest position of the mandible may be defined as that position in which the mandible is involuntarily suspended by the reciprocal coordination of the muscles of mastication and the depressor muscles with teeth separated. In other words, the jaws are separated by the

1. Niswonger, M. E.: Rest Position of Mandible and Centric Relation. J.A.D.A., 21: 1572, September 1934.

minimum amount of muscular contraction sufficient to overcome gravity. This position prevails from the time man is born until he dies. It makes no difference whether the patient is edentulous or not; asleep or awake, it is an anatomic and physiologic arrangement.

During our waking hours, we make a great deal of use of the muscles of the jaw. Talking, chewing, smiling, all tend to tear down tissue, just as action tears down the tissue in other parts of the body. Therefore, it is reasonable to believe that in order to rebuild these broken down parts, Nature has designed this rest position with the minimum amount of muscular contraction to give time and opportunity to restore muscle energy.

Because the depressor muscles become fatigued and endeavor to return the jaw to its rest position, the dentist must constantly tell the patient to open the mouth wider. Make a mental note of how many times during a period of from ten to fifteen minutes you must tell your patients to "open wider." Toward the end of the ten to fifteen minute period, it is necessary to repeat your order more often than in the beginning, owing to depressor muscle fatigue.

The rest position may be assumed voluntarily and is constantly assumed subconsciously. We have observed that when our patients are told to place the jaw "in the rest or relaxed position" or "where it feels most comfortable," immediately they find two positions, a low position and one, a little higher, toward the maxillae. During walking or ascending or descending steps, the jaw moves upward and downward in the range between high and low rest positions. Incidentally, the jaw is considered relaxed.

The relaxed jaw may be the victim of unsuspected force, resulting in fracture of the mandible, or the maxillae, or both. As you know, this does not occur very often; so it seems reasonable to believe that the depressor muscles and muscles of mastication are called on as a defense reflex mechanism to prevent such damage, the operation being similar to the work of shock absorbers. If, however, force is applied too suddenly for the reflexes to act, damage occurs as previously mentioned. Many patients with natural teeth or artificial dentures have complained that they did not know where to hold the lower jaw. They also said that if they closed the jaw until the teeth touched, within a few moments the muscles and teeth became tired. Some have complained of grinding and gritting the teeth, an old story. The treatment of such cases lies in the explanation of the rest position to the patient.

CENTRIC OCCLUSION AND RELATION OF MANDIBLE TO MAXILLAE

Centric occlusion and centric relation will be considered anatomically and physiologically and not mechanically and geometrically. Thus it is hoped to make clear that the tactile muscle sense of centric occlusion remains after the extraction of all upper or lower teeth, or both.

In the act of swallowing, the mandible travels from rest position to centric occlusion and back again. When centric occlusion is reached in the act of swallowing, the lower teeth are held securely in contact against the upper teeth with a minimum amount of pressure. This amount is sufficient, however, for those muscles of deglutition which are attached to the mandible to act, making the swallowing action easy and effective. It is true that one can swallow without using centric occlusion and relation, but the act is strained and forced. Please keep in mind, also, that the word centric means exactly what the word implies, "the center," and anything other than the center is called eccentric. When, in the construction of dentures for edentulous cases, this center or centric occlusion

has been changed downward, upward, forward or laterally from its former position as regards the natural teeth, these anatomic and physiologic arrangements are disorganized and efficiency is greatly impaired. It then becomes eccentric.

Slow motion pictures are an excellent means of studying the reflex mechanism which stops and opens the mandible, and the lateral component combined with the opening and closing component. By the use of subjects whose ages vary from 4 to 60 years, with both natural teeth and artificial dentures, these movements are easily seen, as these pictures slow the movement down to one-third its normal speed.

As far as can be ascertained, my use of this type of movie several years ago was the first attempt to use slow motion pictures for such a study. Hard candy with a soft center was used. If hard candy is used, one can see the result of the reflex mechanism causing the mandible to stop and open long before the teeth are in centric occlusion. Similar reflex is present at centric occlusion with natural teeth after the bolus is fluidized, thereby preventing traumatization of hard and soft tissues. As the bolus becomes more fluid, one can see the mandible move inward and upward toward the maxillae, finally reaching centric occlusion, then rest position. In other words, the mandible seemingly moves vertically and bodily from centric occlusion to rest position before any lateral movements take place.

When chewing gum is used, the mandible seemingly opens from centric occlusion vertically and bodily to rest position. From rest position, one sees the mandible move downward and outward until the bolus is engaged between the occlusal surfaces and then inward and upward toward and into centric occlusion; which again proves without doubt that there is no lateral influence in mandibular movement until after the mandible reaches rest position from centric occlusion. Nature has so arranged the mechanism of mastication that after the bolus has been fluidized, the natural teeth, when they meet in what is called centric occlusion, in masticatory and other movements of the mandible, muscles, ligaments and joints, are in perfect coordination at the end of the upward stroke of the mandible.

This is a highly specialized arrangement. It is at this place that the tactile trigger-like action of the teeth sets off the defense reflexes ending the upward movement of the mandible. This causes the masticatory muscle power to be scattered and the external pterygoids and the depressor muscles to open the jaw, so that injury through traumatizing both hard and soft tissues is reduced. Apparently, it is Nature's scheme not to use forced centric occlusion during the acts of mastication and swallowing and in this trigger-like action. No doubt, forced centric occlusion exercised habitually would cause traumatization of tissues.

Forced centric occlusion may be understood to occur when the maximum power, voluntarily exerted by the muscles of mastication, forces the natural teeth into centric occlusion with or without the presence of food. Yet, during mastication, the natural teeth are not at any time in forced centric occlusion even if the bolus of food is as small as a shredded wheat fiber, or as thin as a lettuce leaf. However, the teeth may be voluntarily forced into centric occlusion with or without the presence of food. Thought and experience will clarify these statements.

As you know, when an inlay or any other kind of prosthesis is a little too high, or if one natural tooth, or more, is unbalanced, removal of the high points reduces the traumatized tissue area. The opening of the bite at centric occlusion in the small amount of the filling is so

significant that it destroys the synchronization of the original centric occlusion. Apparently, it is not so much the unbalanced occlusion, or the high filling, as it is the undissipated muscle power that causes traumatization before the teeth come into original centric occlusion. Is it not reasonable to apply the same principles to full dentures? If not, then the ridges are traumatized, with resorption, dislodgment or breaking of dentures or breaking of the teeth.

Again, it is important to emphasize how muscle power can be relieved of its force and strength before the teeth come into centric occlusion. A good example of how muscle power is thus released is found in the familiar case of the grain of sand caught between the teeth, and yet the grain may be so small that the human eye can scarcely detect it. How many of you have crushed a cherry seed in the teeth? You know what happens. The jaws open before we know it, thereby preventing traumatization of tissues. So it is with a grain of sand, but on a considerably smaller scale.

Another one of Nature's greatest handiworks is manifested in the very thing we are considering now; namely, scattered or dissipated muscle power at centric occlusion with the natural teeth. This highly specialized coordination of muscles and teeth is considered at length in order to introduce a method of establishing vertical relation in the construction of full dentures. The method is based upon the belief that the tactile sense of centric occlusion exists after the extraction of the teeth.

APPLICATION OF REST POSITION AND CENTRIC OCCLUSION TO EDENTULOUS CASES

If we admit that there is a definite rest position and a highly specialized centric occlusion, would it not seem logical, for all practical purposes, to use these two in the construction of artificial dentures?

A measuring instrument which was designed by me and first shown before the Ohio State Dental Society in 1929 measures the distance from rest position to centric occlusion. For several years, it was used to obtain preextraction records. One can also use a Boley gage or any sliding scale that has parallel beaks, for taking this measurement.

The technic for the use of this jaw relator is completely described in THE JOURNAL for September 1934. The jaw relator revealed that edentulous patients could locate their own centric relation and vertical relation. This was discovered by a simple act on the part of the patient, and the jaw relator has now been discarded in favor of the patient's tactile muscle sense of centric occlusion. The procedure is as follows: The edentulous patient is told to place his jaw "where it feels most comfortable," or to relax or to swallow. After swallowing, the jaw returns to the rest position. The patient is told to "close" until he feels that he would be touching his own natural back teeth. These directions are given slowly and deliberately, as this is a new experience to the patient. He is told to repeat placing the jaw in these two positions several times. Usually, he says that he cannot locate these two positions, and at first he thinks he cannot. He is assured that he can to make him feel more confident. This is such a new and simple procedure that even dentists have not recognized its value.

After the patient has become acquainted with this procedure, occlusal rims are built up with compound or wax on hard or ridged baseplates so that they are in even contact throughout while the jaw is in rest position. One rim is pooled and both base-plates are inserted in the mouth. Pooling is very important. The use of compound or wax pooled insufficiently (too hard) or overpooled (too soft) causes failures. The patient is told to imagine that he has all his natural

teeth and to chew into the pooled wax or compound until he thinks his natural back teeth would be touching, or until he can imagine clinching his back teeth. We then find that his tactile muscle sense of centric occlusion will stop the mandible as it did prior to extraction. In fact, patients seem to locate their own centric relation more readily than the dentist can.

Apparently, the specialized tactile muscle sense of centric occlusion is ever-present after extraction of the teeth. Not one edentulous patient has ever failed in the last two years to indicate the same centric occlusion and vertical relation as existed prior to extraction. Even as late as five, six or nine years after extraction, this highly specialized tactile sense was present. I have found that this sense of centric occlusion is so finely developed that if too much adhesive powder is used, patients chew or squeeze out the excess until they register this sense of centric occlusion. They may even build up enough adhesive powder to prevent the mandible from going beyond centric occlusion.

After following these deductions, it seems that one of the most hazardous undertakings in making full dentures is changing the vertical relation and centric occlusion as they existed prior to extraction.

As has been mentioned before, there exists a perfect coordination between the muscles, joints, ligaments and natural teeth during mastication, and also during other movements of the mandible at centric occlusion and rest position. We must endeavor to establish an identical coordination of the same tissues with artificial dentures at centric occlusion and rest position. Hence, less time is required to become accustomed to the dentures, and, therefore, greater efficiency is obtained in speech and mastication. The farther away we get from this, the more difficult it is for patients to wear artificial dentures. If an inaccurate centric occlusion is established by the dentist, Nature may evolve a new centric occlusion through a slow change of both hard and soft tissues. This will take place during the time patients are trying to become accustomed to the dentures. It is probable that the patients will be dissatisfied and discouraged during this slow period of change, creating in the mind of the dentist some doubt as to the procedure.

Furthermore, in a study made of patients, including immediate denture patients who have masticated their first meal with full artificial dentures, it was found that centric occlusion and vertical relation were the same as had existed with natural dentures. Study of successful cases sometimes reveals interesting and valuable data.

It is not necessary to tell the immediate denture enthusiasts of the desirability of securing and maintaining centric occlusion and the vertical relation as it existed prior to extraction. They know that by doing so mastication, phonation, deglutition and esthetic values are not impaired. Likewise, such desired results can be obtained by using the tactile muscle sense of centric occlusion along with the following methods now used in securing centric relation. In other words, tactile muscle sense works with the following methods:

1. A gothic arch tracing can be made above or below true centric occlusion as it existed prior to extraction. If a gothic arch tracing is used, the tactile muscle sense of centric occlusion will provide a means whereby these tracings can be correctly made at preextraction centric occlusion.

2. If the closure of the lips in obtaining the centric relation is the guide, the tactile muscle sense of centric occlusion will help to disprove the theory that the lips should be together. The lips are separated just as often as closed at both

centric occlusion and rest position. However, when the lips are closed, the muscles of the lips gently bring the lips together, but do not hold them in this position. This closure is maintained somewhat by muscle tone, but mostly by saliva and mucus sealing the lips together.

3. If baseplate rims are trimmed so that they are even with the lips and high and low lip lines made, the tactile muscle sense of centric occlusion will prove that these are not guides to follow in securing centric relation.

4. If spoken words are used as the determining factor in this problem of true centric occlusion, the tactile muscle sense of centric occlusion will point out the many shortcomings of the spoken words method.

5. If the mush bite has been used, one will understand why this bite, careless as it is, has been the simplest means whereby the patient and the dentist, either by themselves or together, sometimes secure true centric occlusion, unknowingly, unintentionally and accidentally.

6. If the sense of facial proportion has been used to determine esthetically the proper opening and closing of the mandible, the tactile muscle sense of centric occlusion will assist in developing this sense of proportion. At present, the dentist's sense of proportion is very vague, since only a few dentists are sculptors. Think of the feeble attempt to reproduce anatomic form in inlays and alloy restorations by means of the sense of proportion.

Any external esthetic factors other than vertical relation must be developed at the rest position of the mandible, not at centric relation or centric occlusion, since the mandible is seen at centric occlusion only momentarily during the act of mastication and swallowing. In these two acts, Nature has apparently used motion to eliminate the unsightly appearance of protruding lips and of nose and chin in proximity.

SUMMARY

1. Rest position of the mandible is an anatomic and physiologic arrangement of the oral tissues.

2. The sense of centric occlusion is due to an anatomic and physiologic arrangement of tissues and is present after extraction of all the upper teeth or lower teeth, or both.

3. Rest position, centric occlusion and centric relation are closely related in mandibular movements.

As we understand more about these relationships of the jaws and means of recording them, prior to extraction or afterwards, the vertical relation will be more correctly obtained, controlled and used.

720 Fidelity Building.

THE JOURNAL *of the*
AMERICAN DENTAL ASSOCIATION
and THE DENTAL COSMOS*

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Published by the American Dental Association
212 East Superior St., Chicago, Ill.

All expressions of opinions and all statements of supposed facts are published on the authority of the writer over whose signature they appear, and are not to be regarded as expressing the view of the American Dental Association, unless such statements or opinions have been adopted by the Association.

Communications intended for publication in the scientific or literary pages of THE JOURNAL should be addressed to the Editor. All advertising or business matter should be sent to the Business Manager.

Subscription is included in the annual membership dues. The subscription rate to non-members is $5.00 a year in advance, this rate applying to both domestic and foreign subscriptions. All foreign subscriptions are to be paid in United States money.

*In deference to the wish of the dental profession to control its literature, *The Dental Cosmos*, founded in 1859, was transferred by the publishers as a gift to the American Dental Association, January 1937.

**Deceased.

DENTAL INTERNSHIP

THE development of dentistry from its biologic aspect, as expressed in the relationship of dental disease to systemic disease, has been responsible for a special effort toward cultivating a closer cooperation between medicine and dentistry.

The present basis of dentistry is biologic; its mechanical procedures are not ends in themselves but are engineering problems in relation to a biologic field.

If one were to seek for the main underlying cause of the revolutionary changes that have led up to the present-day conception of the purpose of dental science and art, it would undoubtedly be found to be the germ theory of the causation of disease.

The researches of Miller and Black on the etiology of dental caries,

leading to our present-day knowledge of the bacterio-pathology of the oral cavity and the causal relation of mouth infection to systemic disease, have given to both the science and art of dentistry a new birth and a vigorous growth, with the result that the objectives of dental practice have become primarily vital rather than mechanical.

In a fundamental sense, then, it is the recognition of the biologic factor and the new mental attitude of the dental profession resulting from this recognition of the vital importance of that factor that constitute the greatest forward step of dentistry.

It is the motive power of that factor that has reorganized our educational curriculum, changed the entire system of dental technic and bred the multiplicity of specialties in dentistry.

One of the principal factors in the further development of the clinical relation of dentistry to systemic diseases, and one that has not been developed to its full potentiality, is that of intern service preparatory to the practice of dentistry.

The indispensability of internship as preparatory to intelligent medical practice has long since been recognized in medicine to the extent that in some twenty-five states of the Union a two-year internship has become one of the basic requirements for licensure; nor is the prospective specialist in any phase of the healing arts exempt from the aforesaid preparational requirement. Furthermore, the intensive education demanded in any specialty of medicine has made it even more necessary that additional specialized education be gained through hospital internship.

Dentistry, having become a recognized specialty of the healing art almost on a level with the other specialties, has also come to require the educational benefits that may be acquired from the clinical experience which the internship affords and has, within recent years, paid definite attention to its development.

Clinical experience in, and study of, the cause and effect relation of dental disease to bodily disease has produced most convincing proof of the almost unlimited benefits to be gained in both medical and dental practice, so much so, that it is evident that the development of this relationship between medicine and dentistry is likely to be pursued to its finality—compulsory internship as a requisite for dental practice.

A necessary preliminary, however, to intern experience being made compulsory is a broader recognition of the benefits in and to both medical and dental practice. It seems that the hospitals, through exper-

ience, are in a most receptive mood to applying the new, or dental, ancillary clinical aid in attaining a more complete medical service.

There are many instances of individual dentists, groups of dentists and dental societies exerting their influence toward the employment of dental attendants and interns in various hospitals, mainly for the purpose of demonstrating the value which the dental attendant or intern may be to hospital service. We are under the impression, however, that the favorable attitude which the hospitals have shown to the dental intern is the result of a slowly evolving conviction of the value of the service demonstrated by the somewhat spectacular reactions in systemic diseases to proper attention to the dental causal condition; this as supplementary to the constant efforts on the part of the dental profession to convince the medical profession and the public that there are numerous systemic conditions that are related in a causal manner to dental disease.

One of the primary purposes of the internship for the dental graduate is, of course, to supplement the education of both the dental intern and the medical intern, as it is quite generally recognized, and has been for many years, that the undergraduate medical student is not taught sufficient dentistry, nor is the undergraduate dental student taught sufficient medicine. And this applies more acutely to the instruction of the dental student in the clinical aspects of disease.

Among the benefits to be realized from dental attention to the hospital patient is that the duration of disease is materially lessened and, too, the convalescent period is much shortened when the mouth is kept in a healthy condition. Then, also, the contact of the medical student with the dental student is a relation that has been shown to be of greatest benefit in the diagnosis and treatment of dental conditions which influence bodily health, and this particularly in cases in which the medical man has been too quick to condemn teeth to the forceps. On the other hand, the intern system establishes an association for the dental student that, in a measure, tends to relieve the stress which, in the nature of the case, he has been compelled to put upon technic; to the end that he may develop an appreciation of dental health values as related to systemic conditions and also a higher sense of moral responsibility to the community.

For several years there has been, and, in fact, at the moment there is, a definite effort being made by the American Dental Association to enlarge the opportunities for dental internship, until at present there are one hundred and twenty hospitals throughout the country offering

one hundred and eighty internships. In addition thereto, there are some fifty-four internships available in the Marine hospitals and in the penitentiaries.

While we do not consider it pertinent or timely as yet to suggest that internship be made a compulsory requisite to dental licensure, we do believe that the present period of trial of the system will so convincingly prove the benefits to be obtained therefrom that some day we may evolve to that educational status.

Another phase of the intern's activities that may lead to incalculable benefits to dentistry is that of aid in gathering statistics to prove the economic value of mouth health to patients of all classes. Many such statistics have been made by physicians and nurses, but the lack of understanding and appreciation of the dental point of view is such as to make statistics gathered under such circumstances practically useless.

We have in mind an instance in which mouth examinations were made by physicians and nurses in a group of hospital patients, the same group being reexamined later by dental interns. The physicians and nurses reported 67 per cent of those examined as having no decay, whereas the dental interns reported a percentage of only 2.7 of the same group as having no decay. This quite graphically illustrates the necessity of examination of mouth conditions being conducted by those dentally qualified and, incidentally, it shows the valuelessness of many of the dental data that have been gathered by some of the social welfare groups.

Another benefit that undoubtedly will come to the graduate dental student from such a hospital association as the internship affords is the development of an appreciation of the value of making and studying case records—a phase of clinical dental practice that has not yet been developed to its full possibilities. And in the light of the constantly increasing demand for a higher efficiency in dental practice, it behooves us to cultivate and develop every facility for meeting the new requirements.

It has been pertinently suggested that, in our present state of educational transition, what we need is evolution more than revolution, and our earnest hope is that the internship may be instrumental in evolving the dental graduate into an efficient unit in the community health service.

L. P. A.

COUNCIL ON DENTAL THERAPEUTICS

ACCEPTED DENTAL REMEDIES

The Council on Dental Therapeutics of the American Dental Association announces the inclusion of the following articles in the list of Accepted Dental Remedies.

Mallinckrodt Products

The following products of Mallinckrodt Chemical Works are admitted to Accepted Dental Remedies as brands of drugs listed in the book. They will appear in the next edition of Accepted Dental Remedies.

Acetanilid USP XI Powd.	Acetone USP XI
Acetophenetidin USP XI	Acid Acetylsalicylic USP XI Powd.
Acid Arsenous USP XI Powd.	Acid Benzoic USP XI Synthetic
Acid Boric USP XI Powd.	Acid Carbolic Liquid USP XI
Acid Carbolic Crystals USP XI	Acid Chromic USP XI
Acid Hydrochloric Dil. USP XI	Acid Hydrochloric USP XI
Acid Nitric USP XI	Acid Phosphoric USP XI Syrupy 85%
Acid Sulfuric USP XI	Acid Tannic USP XI Fluffy
Acid Tannic USP XI Powd.	Acid Trichloracetic USP XI
Alum Ammonium USP XI Powd.	Alum Potassium USP XI Gran.
Alum Potassium USP XI Exsiccated Powd.	Aluminum Acetate Pure Basic
Aminopyrine USP XI Powd.	Ammonia Water USP XI Stronger
Ammonium Acetate Pure	Ammonium Carbonate USP XI Lumps
Atropine Sulfate USP XI	Barbital USP XI
Barbital Soluble USP XI	Benzocaine USP XI
Betanaphthol Resub. USP XI	Bismuth Subcarbonate USP XI
Bismuth Subnitrate USP XI	Caffeine Alkaloid USP XI
Caffeine Citrated USP XI	Caffeine Sodio-Benzoate USP XI
Calcium Carbonate Precip. USP XI	Calcium Chloride USP XI Gran.
Calcium Gluconate USP XI	Calcium Hydroxide USP XI
Calcium Lactate USP XI	Chloramine-T USP XI
Chloroform USP XI	Chloroform Purified for Anesthesia
Copper Sulfate USP XI Cryst.	Corrosive Sublimate USP XI Powd.
Creosote USP XI	Cresol USP XI
Cresol Solution Compound USP XI	Ether for Anesthesia
Ether USP XI	Eucalyptol USP XI
Formaldehyde Solution USP XI	Glycerin USP XI
Guaiacol Liquid USP XI	Guaiacol Carbonate NF VI
Hydrogen Peroxide USP XI	Iodine USP XI Resub. Crys.

Iodine USP XI Resub. Gran.
Iodine Tr. USP XI Mild
Iodine Tr. USP XI
Iodoform USP XI Powdered Heavy
Iodoform USP XI Powdered Light
Iron Subsulfate Powder
Iron Subsulfate Solution NF VI
Iron Sulfate Crystals USP XI
Lanolin USP XI
Lanolin USP XI Anhydrous
Lunar Caustic USP XI
Magnesium Carbonate USP XI Powd.
Magnesium Carbonate USP XI Heavy
Magnesium Oxide Heavy USP XI
Magnesium Oxide USP XI Light
Magnesium Sulfate USP XI
Menthol USP XI
Mercury USP XI Redistilled
Methyl Salicylate USP XI
Paraformaldehyde
Phenobarbital USP XI
Phenobarbital Sodium USP XI
Pilocarpine Nitrate USP XI Crys.
Pilocarpine Hydrochloride NF VI Crystals
Potassium Bicarbonate USP XI Crys.
Potassium Bromide USP XI Crys.
Potassium Bromide USP XI Gran.
Potassium Bromide USP XI Powd.
Potassium Mercuric Iodide NNR
Potassium Permanganate USP XI Crys.
Procaine Hydrochloride USP XI
Resorcinol USP XI Powdered
Resorcinol USP XI Crystals
Saccharin USP XI Sol. Powd.
Saccharin USP XI Refined
Silver Nitrate C.P. Crystals
Silver Lactate
Silver Nucleinate
Silver Proteinate
Sodium Bicarbonate USP XI Powd.
Sodium Borate A.R. Crystals
Sodium Bromide USP XI Gran.
Sodium Bromide USP XI Powd.
Sodium Chloride USP XI Gran.
Sodium Perborate USP XI
Sodium Peroxide
Strychnine Sulfate USP XI Crys.
Thymol USP XI Crystals
Thymol Iodide USP XI
Zinc Chloride USP XI Gran.
Zinc Chloride Sticks A.R.
Zinc Oxide A.R.
Cocaine Hydrochloride USP XI
Codeine Alkaloid USP XI
Codeine Phosphate USP XI
Codeine Sulfate USP XI Powd.
Morphine Sulfate USP XI Powd.

Manufactured by Mallinckrodt Chemical Works, St. Louis, Mo. No U. S. patents or trademarks.

Dentifrices*

Rogers Dental Cream.—Composition: See Craig-Martin Tooth Paste (A.D.R. 1938, page 114).

Manufactured by The Comfort Manufacturing Co., Chicago, Ill. Distributed by Read Drug and Chemical Co., Baltimore, Md.

Local Anesthetics†

Guild Procaine Solution 2% with Epinephrine 1:50, 000: Each cubic centimeter is said to contain procaine hydrochloride, U.S.P., 0.02 gm.; epinephrine, 0.00002 gm.; chlorbutanol, 0.005 gm.; sodium chloride, 0.0037 gm.; sodium bisulfite, 0.0019 gm., and disodium phosphate, 0.0019 gm., in distilled water.

*A.D.R. 1938, page 112.
†A.D.R. 1938, p. 36.

Manufactured by the Guild Anesthetic Laboratories, Chicago, Ill. No U. S. patent or trademark.

Guild Procaine Solution 2% with Epinephrine 1:50,000 in Tubes.

Guild Procaine Solution 2% with Epinephrine 1:25,000: Each cubic centimeter is said to contain procaine hydrochloride, U.S.P., 0.02 gm.; epinephrine, 0.00004 gm.; chlorbutanol, 0.005 gm.; sodium chloride, 0.0037 gm.; sodium bisulfite, 0.0019 gm., and disodium phosphate, 0.0019 gm., in distilled water.

Manufactured by the Guild Anesthetic Laboratories, Chicago, Ill. No U. S. patent or trademark.

Guild Procaine Solution 2% with Epinephrine 1:25,000 in Tubes.

Admission of an article to the list of Accepted Dental Remedies does not imply a recommendation. Information on the rules and work of the Council will be sent on request.

HAROLD L. HANSEN, *Secretary.*

COLGATE'S RIBBON DENTAL CREAM—NOT ACCEPTABLE FOR A.D.R.

Report of the Council on Dental Therapeutics of the American Dental Association, authorized for publication.

IN 1930, Colgate's Ribbon Dental Cream was admitted to A.D.R. At that time, the firm manufacturing this product apparently shared the Council's opinion as to the function of a dentifrice and agreed to abide by this definition in advertising. In 1934, Colgate's Ribbon Dental Cream was omitted from A.D.R. because of claims made for the product. At that time, the firm advertised that Colgate's Ribbon Dental Cream will remove seven kinds of stain. These seven kinds of stains were said to be due to "(1) meats and other proteins, (2) cereals and other starchy foods, (3) vegetables, (4) sweets, (5) fruits, (6) beverages, (7) tobacco smoke." As far as the Council is aware, there is no evidence to substantiate these claims. Nor did the firm submit any such evidence, even though they were requested to do so. Subsequently to this, the Colgate-Palmolive-Peet Company embarked on an advertising campaign in which Colgate's Ribbon Dental Cream, which bears the seal of approval of the Good Housekeeping Bureau, is claimed to combat bad breath and to remove that which "causes much dental decay."

Current advertising for the Colgate-Palmolive-Peet Company reads in part as follows:

> Colgate Dental Cream combats Bad Breath. . . . You see, Colgate's special penetrating foam gets into hidden crevices between your teeth that ordinary cleansing methods fail to reach. . . . Emulsifies and washes away the decaying food deposits that cause most bad breath. . . . Dull, Dingy Teeth . . . and much tooth decay and at the same time Colgate's soft, safe polishing agent gently yet thoroughly cleanses and brightens the enamel.

The advertising is presented in a form apparently designed to create the impression that the dentist makes these claims for the product.

A review of the literature on the topic variously designated as "bad breath," halitosis or *fetor ex ore* indicates that much of the relatively scant material that has been written is based largely upon opinion rather than upon either laboratory findings or carefully controlled clinical observation. It would, therefore, appear that if the Colgate-Palmolive-Peet Company is in possession of data

which will substantiate the claims advanced for their dental cream, the dental profession should be allowed to share this information.

That expressions of opinion on the subject of "bad breath" are not new is indicated by the fact that Pliny the Younger, in his "Natural History," specifically mentions this topic.

The present status of the subject, while it is on a somewhat more scientific plane than was true in Pliny's day, is still far from being satisfactory. Although the Council does not pretend to present at this time an exhaustive review on all of the possible ramifications of the subject, it does believe that the following material amply illustrates the point that apparently all writers do not claim that "most bad breath is caused by decaying food particles in hidden crevices between the teeth."

Stallard (J.A.D.A., 14:1689, September 1927) wrote: "Foul breath may be due to all sorts of disorders. . . . By experimentation, it was found that when an edentulous person chewed macerated onions without swallowing any, the odor, though less pronounced, was noticeable almost as long as in a person having teeth. The mucosa of the cheeks and lips retain the odor longer than do the teeth, but not so long as the palate and the dorsum linquae."

Ferris (J.A.D.A., 14:1692, September 1927), in a discussion of Stallard's paper, pointed out that bad breath may come from extensive cases of burns, chronic alcoholism, obstructions of the alimentary canal, nephritis, epilepsy and necrotic states in the oral cavity and is present in cases of chronic metallic poisoning.

Canan *(Am. J. Clin. Med.,* 269, 1918) wrote: "Bad breath may be owing to local causes or systemic disease . . . local causes are dental caries, decaying food particles adhering to the teeth, pyorrhea alveolaris, nasal diseases such as chronic hypertrophic rhinitis, gangrenous stomatitis, necrosis of the jaws, diseases of the tonsils, pharynx and larynx."

Howe, in his book "The Breath" (1880), said "An offensive breath is a functional disorder liable to occur at all periods of life."

Eisenberg *(Am. D. Surg.,* 47:298, May 1927) is of the opinion that halitosis is caused by absorption of foul odors of the digestive system by the saliva.

Hartzell (J.A.D.A., 18:1110, June 1931) believes that the real source of common mouth odors is the surface of the tongue. He adds, "There is one other source and that is putrefaction of the material in the nose."

Prinz *(D. Cosmos,* 72:700, July 1930) lists eight causes of bad breath, but is inclined to the opinion that most of the cases of offensive breath originate from prolonged stagnation of food débris about the mouth.

Haggard and Greenberg *(J.A.M.A.,* 104:2160, June 15, 1935), in a recent investigation, found that the odor of onions and garlic is retained in the mouth for long periods of time and that brushing the teeth and cleaning the base of the tongue had no effect in overcoming the odor. They did find that the use of chlorine-containing solutions reduced the intensity of the odor markedly.

From the foregoing, it would appear that there may be many causes of "bad breath." On that basis, it is difficult to understand how a preparation of the Colgate Ribbon Dental Cream type[1] could be successfully used to combat most cases of bad breath. Even if one were inclined to the opinion that most of these cases have their origin in the presence of decaying food particles

1. In 1930, the product was stated by the firm to have the following composition: Each 100 gm. contains glycerine 28.0 gm.; soap (vegetable), 5.0 gm.; calcium carbonate, 35.7 gm.; precipitated chalk, 7.6 gm.; sodium benzoate, 2.1 gm.; aromatics, 0.9 gm.; cornstarch, 6.5 gm.; water, 14.2 gm.

around the teeth, it would seem logical to assume that the proper use of the toothbrush would play the major rôle in the removal of such débris in areas accessible to the brush. And as far as the Council is aware, there is no basis for the claims that Colgate's tooth paste possesses a special penetrating foam which can emulsify and wash away decaying food particles lodged in hidden crevices of the teeth, which "ordinary cleansing methods fail to reach."

The inferential claim that Colgate's Ribbon Dental Cream is of value in combating dental caries by removing the decaying food material which "causes much tooth decay" is apparently not supported by sound evidence. From the strictly technical point of view, the ability of Colgate's Ribbon Dental Cream to "emulsify and wash away" such dissimilar mixtures as proteins and their degradation products and carbohydrates and their degradation products might also be seriously questioned.

In his book on "Operative Dentistry," Vol. 3, page 39, Black wrote concerning the usefulness of dentifrices and mouth washes in mouth hygiene:

> No mention has been made of mouth washes, tooth pastes, tooth powders, etc. It is believed that these are of little or no value. . . . The idea has become so fixed in the minds of our people as a result of advertising propaganda by manufacturers and the belief of many dentists that these preparations are beneficial, that it is not to be expected that the public or the members of the profession will quickly change their attitude, but in the light of present knowledge, there should be a gradual change to a more rational view.

The Council on Dental Therapeutics rightfully holds that the treatment of dental caries belongs to the dental profession and further that many cases of bad breath are sufficiently serious to warrant the attention of either physician or dentist or both. Advertising propaganda based upon claims that a dentifrice can prevent much tooth decay, no matter how cleverly worded that advertising may be, is opposed to the best interests of the profession and the public.

Since the claims advanced for Colgate's Ribbon Dental Cream are false and misleading, the Council on Dental Therapeutics finds this dentifrice is not acceptable for A.D.R.

A copy of the rules that govern the Council in the consideration of articles will be sent on request.

HAROLD L. HANSEN, *Secretary.*

ASSOCIATION ACTIVITIES

RESEARCH COMMISSION

LISTS OF CERTIFIED DENTAL MATERIALS

(As of October 1, 1938)

THE A.D.A. Research Commission in cooperation with the National Bureau of Standards, has developed specifications for the following materials: amalgam, inlay investment, impression compound, inlay casting wax, inlay casting gold alloy, mercury, wrought gold wire, zinc phosphate cement and silicate cement.

Samples of the foregoing materials which were certified to the Research Commission by the various manufacturers as complying with the A.D.A. specifications were procured on the retail market by the Research Commission and were tested by the A.D.A. Research Associates at the National Bureau of Standards. The following certified materials were found to comply with the A.D.A. Specifications. Certified materials which did not comply with specifications are omitted from the lists.

Materials listed below are constantly being tested. Therefore, the lists are subject to revision from time to time. The revised lists will be published in the JOURNAL. These lists are your buyers' guide.

Certificates of the following materials were withdrawn from the lists by their respective manufacturers for reasons other than failure to comply with the specifications:

Kerr No. 3 Inlay Investment
Ransom and Randolph X-45 Investment
Kerr No. 3 Impression Compound
Garhart's Positively Pure Mercury
Ney-Oro Elastic No. 2—Wrought Gold Wire

CERTIFIED AMALGAM ALLOYS (A.D.A. SPECIFICATION NO. 1.)

Alloy	Manufacturer or Distributor
Accurate Metalloy (filings)	The L. D. Caulk Co.
Ackerman (filings)	Ackerman Dental Mfg. Co.
Argentum ("A" cut)	Hammond Dental Mfg. Co.
Aristaloy	Baker & Co., Inc.
Banner (filings)	Goldsmith Bros. S. & R. Co.
Blue Diamond (filings)	Reliance Dental Mfg. Co.
Brewster Medium (shavings); Quick (filings); Quick (shavings)	E. R. S. Brewster
Capeako (filings)	Precious Metals Refining Works
Certified	Lee S. Smith & Son Mfg. Co.
Coe	Coe Laboratories, Inc.
Cresilver	Crescent Dental Mfg. Co.
Dee (filings)	Thomas J. Dee & Co.
Diamond Edge	Young-Baker Co.
Excel	Daniels Dental Alloy Co.
Fleck's	Mizzy, Inc.
Minimax (filings) 173, 174, 177, 178, 180, 181, 183, 161, (shavings) 173, 177, 178, 161	The Minimax Co.
Minimax White Gold & Platinum	

Mission No. 5	Henry F. Bruce Co.
Mission No. 5 ("A" cut)	Henry F. Bruce Co.
Mission No. 6	Henry F. Bruce Co.
Modeloy (Quick Setting) (filings)	Crescent Dental Mfg. Co.
Ney-Aloy	The J. M. Ney Co.
Ney's No. 125	The J. M. Ney Co.
Odontographic "Improved" (filings)	Odontographic Mfg. Co.
Pearlol	Wildberg Bros. S. & R. Co.
Preferred C	Precious Metals Refining Works
Preferred D	Precious Metals Refining Works
Research Oralloy	Precious Metals Research Works, Inc.
Silver Crown	General Refineries, Inc.
Silver Crown (Medium)	General Refineries, Inc.
Silverloy (filings), Silverloy (shavings)	Crescent Dental Mfg. Co.
Speyer	Speyer Smelting & Refining Co.
S-C Medium (filings); S-C Quick (filings)	Stratford-Cookson Co.
True Dentalloy (filings)	The S. S. White Dental Mfg. Co.
True Dentalloy (cut "A")	The S. S. White Dental Mfg. Co.
Twentieth Century (Regular)	The L. D. Caulk Co.
Twentieth Century (Special)	The L. D. Caulk Co.
Uniform	Henry Nelms & Son
White Beauty	Lang Dental Mfg. Co.

CERTIFIED INLAY CASTING INVESTMENTS (A.D.A. SPECIFICATION NO. 2.)

Investment	Manufacturer or Distributor
Coecal Inlay	Coe Laboratories, Inc.
Coecal Universal	Coe Laboratories, Inc.
Kerr Cristobalite-Inlay	Detroit Dental Mfg. Co.
Ransom and Randolph Gray	The Ransom & Randolph Co.
Ransom and Randolph Green	The Ransom & Randolph Co.
S. S. White Inlay No. 20	The S. S. White Dental Mfg. Co.
Security Improved Inlay	The Cleveland Dental Mfg. Co.
Steele's-Super	The Columbus Dental Mfg. Co.

CERTIFIED IMPRESSION COMPOUNDS (A.D.A. SPECIFICATION NO. 3.)

Compound	Manufacturer or Distributor
Brewster	E. R. S. Brewster
Certified	Lee S. Smith & Son Mfg. Co.
Dresch	The Ransom and Randolph Co.
Kerr Black	Detroit Dental Mfg. Co.
Kerr Perfection	Detroit Dental Mfg. Co.
Kerr White	Detroit Dental Mfg. Co.
Mizzy—Low Heat	Mizzy, Inc.
Moyer	The J. Bird Moyer Co.
S. S. White—Black—Tray	The S. S. White Dental Mfg. Co.

CERTIFIED INLAY CASTING WAXES (A.D.A. SPECIFICATION NO. 4.)

Wax	Manufacturer or Distributor
Brewster	E. R. S. Brewster
Caulk-Blue	The L. D. Caulk Company
Kerr-Blue—Hard	Detroit Dental Mfg. Co.
Maves	The Heidbrink Co.
Peck's Blue	A. E. Peck Mfg. Co.
Security	The Cleveland Dental Mfg. Co.
Sterling	Baker & Co., Inc.

CERTIFIED INLAY CASTING GOLD ALLOYS (A.D.A. SPECIFICATION NO. 5.)

Alloy		Manufacturer or Distributor
Aderer-A-Soft	A	Julius Aderer, Inc.
Aderer-B-Medium	B	Julius Aderer, Inc.
Aderer-C-Hard	C	Julius Aderer, Inc.

Baker Inlay Soft	A	Baker & Co., Inc.
Baker Inlay Medium	B	
Bruce "A"	C	Henry F. Bruce Co.
Bruce "O"	C	
Bruce No. 5	C	
Chilcast No. 1	A	Vernon-Benshoff Co.
Chilcast No. 1-A	B	
Chilcast No. 2	C	
Chilcast No. 2-A	B and C	
Crown Do-All-Casting	C	General Refineries, Inc.
Crown Inlay No. 2—Soft	A	
Crown Inlay No. 1—Hard	B	
Crown No. 9	C	
Crown K	A	
Crown Knapp No. 2	B	
Crown Knapp No. 3	B	
Crown T	B	
Crown TT	C	
Deetwo Light	A	Thomas J. Dee & Co.
Deetwo	B	
Dressel	C	Julius Aderer, Inc.
Goldsmith Inlay No. 1	A	Goldsmith Bros. S. & R. Co.
Goldsmith Inlay No. 2-Medium	B	
Goldsmith Inlay No. 3-Hard	C	
Jelenko Alboro Inlay	C	J. F. Jelenko & Co., Inc.
Jelenko Durocast	C	
Jelenko Firmilay	C	
Jelenko Modulay	B	
Jelenko Platin-Cast	B	
Jelenko Special Inlay	A	
Lite Wite Inlay	C	Precious Metals Research Works, Inc.
Lite Wite Hard Inlay	C	
Mowrey B. Inlay	B	W. E. Mowrey Co.
Mowrey-Special Inlay	C	
Mowrey T Gold	B	
Mowrey TT	C	
Nelms E	B	Henry Nelms & Son
Nelms J	C	
Ney-Oro A	A	The J. M. Ney Co.
Ney-Oro AA	A	
Ney-Oro A-1	B	
Ney-Oro A-10	B	
Ney-Oro B	C	
Ney-Oro B-2	C	
Research-A-Soft	B	Precious Metals Research Works, Inc.
Research-B-Medium	C	
Research-Inlay	C	
Research-Hard Cast No. 5	B	
Spyco Hard	B	Spyco Smelting and Refining Co.
Spyco Soft	A	
Spyco No. 6	C	
S. S. White No. 1	B	The S. S. White Dental Mfg. Co.
S. S. White No. 2	A	
S. S. White No. 13	C	
S. S. White No. 31 Metalba	B	
S. S. White No. 820	B and C	
S. S. White No. 860-Hard	C	
S. S. White No. 940	A	

Stern A-T (No. 2381)	C	I. Stern and Co.
Stern No. 6219	B	
Stern No. 2847	C	
Stern No. 3290	B	
Stern No. 3337	C	
Stern No. 3375	A	
Stern No. 3441	C	
Stern No. 3465	B and C	
Tinker No. 1	B	Spyco Smelting and Refining Co.
Tinker No. 1H	C	
Tinker No. 2	C	
Tinker Inlay	B	
Williams-Klondiker	C	The Williams' Gold Refining Co., Inc.
Williams-Pioneer	C	

*Relative hardness: A, soft; B, medium; C, hard

CERTIFIED DENTAL MERCURIES (A.D.A. SPECIFICATION No. 6.)

Mercury	Manufacturer or Distributor
Argentum	Hammond Dental Mfg. Co.
Chemically Pure	The S. S. White Dental Mfg. Co.
Dee	Thomas J. Dee & Co.
Dental	Goldsmith Bros. S. & R. Co.
Mercury Laboratories	Mercury Laboratories, Inc.
Minimax	The Minimax Co.
Mission	Henry F. Bruce Co.
Moyco	The J. Bird Moyer Co.
Mynol	Mynol Chemical Co.
Ney's C. P.	The J. M. Ney Co.
Odontographic	Odontographic Mfg. Co.
R. P. C.	Research Products Corporation
Spectropure	Baker & Co., Inc.
Twentieth Century	The L. D. Caulk Co.
Williams	The Williams Gold Refining Co.

CERTIFIED WROUGHT GOLD WIRE ALLOYS (A.D.A. SPECIFICATION No. 7.)

Alloy	Manufacturer or Distributor
Aderer No. 1	Julius Aderer, Inc.
Aderer No. 3	
Aderer No. 4	
Aderer No. 20 Clasp	
Baker Q. A.	Baker & Co., Inc.
Crown Hylastic	General Refineries, Inc.
Deepep-Hard	Thomas J. Dee & Co.
High Fusing Clasp	Goldsmith Bros. S. & R. Co.
Jelenko No. 3 Wire	J. F. Jelenko & Co., Inc.
Jelenko Super Wire	
Medium Clasp	Goldsmith Bros. S. & R. Co.
Ney-Oro Elastic No. 4	The J. M. Ney Co.
Neydium 9	
Regular Clasp	Goldsmith Bros. S. & R. Co.
Spyco No. 3	Spyco Smelting and Refining Co.
Stern No. 2657	I. Stern and Co., Inc.

CERTIFIED ZINC PHOSPHATE CEMENTS (A.D.A. SPECIFICATION No. 8.)

Cement	Manufacturer or Distributor
Ames Z-M	The W. V-B Ames Co.
Caulk, Crown & Bridge	The L. D. Caulk Co.
Caulk, Petroid Improved	
Caulk, Tenacin	

Fleck	The J. R. Stanley Chemical Co.
Lang	Lang Dental Mfg. Co.
S-C	Stratford-Cookson Co.
Smith	Lee S. Smith & Son Mfg. Co.
S. S. White, Zinc	The S. S. White Dental Mfg. Co.

Survey of Certified Silicate Cements

Samples of silicate cements, certified to the Research Commission of the American Dental Association by the various manufacturers, prior to September 1, as listed herein were procured on the open market by the Research Commission and tested by the A.D.A. Research Associates at the National Bureau of Standards. As of October 15, 1938, the following list of silicate cements were found to comply with the American Dental Association Specification No. 9. Certified silicate cements which did not comply are omitted from this list.

Certified Silicate Cements (A.D.A. Specification No. 9.)

Cement	Manufacturer
Astralit	Premier Dental Products Co.
Baker Plastic Porcelain	Baker & Co., Inc.
DeTrey's Synthetic Porcelain	The L. D. Caulk Co.
Durodent Enamel	Oskar Schaefer
Smith's Certified Enamel	Lee S. Smith & Son Mfg. Co.
S. S. White Filling Porcelain, Improved	The S. S. White Dental Mfg. Co.

COMMITTEE ON LEGISLATION

TEXAS DENTAL LAW

The Supreme Court of the state of Texas, in declining to review a case in which a lower court has affirmed the constitutionality of the Texas dental law, upheld the decision of the lower court and denied the claims made by opponents of the law, who had attacked its constitutionality, charging, among other things, that it violated the constitutional guarantee of freedom of the press and speech.

The opinion of the lower court, which the Supreme Court sustained, asserted that the dental license was a property, not a vested right and might be revoked for cause. It said that those engaged in the practice of dentistry, as well as of medicine and surgery and related vocations, were subject to legislative regulation under police powers granted by the constitution to protect the public welfare and that this power did not necessarily rest on the theory that such advertising must be false or harmful within itself in every case.

The court also said that the statute had no bearing on the freedom of the press because the press could continue to publish what it saw fit and the act should not be nullified because "conjectural revenue" of the press might be cut off.

In upholding this decision of the Court of Appeals, the Texas Supreme Court added Texas to the growing list of states that have upheld regulation of the practice of dentistry, particularly dental advertising.

Enforcement of this law has been opposed by advertising dentists of Texas. Presumably, their next step would be to ask the court to reconsider. Should the court refuse to change its opinion, these

parties have threatened to try to defeat the purpose of the law by having the legislature amend it. However, the dentists of Texas are ready to fight to maintain the law in its present form, and with such an important supporting decision, the defense of the statute should be less difficult.

POWER OF STATE TO RESTRICT OWNERSHIP OF DENTAL OFFICES TO LICENSED DENTISTS

By Leslie Childs, Indianapolis, Ind.

THE power of a state to restrict the practice of dentistry to duly licensed persons is not open to question, and the courts have uniformly upheld such legislation as a valid exercise of the police power. But the validity of such regulation in respect to owning or operating a dental office where this function is entirely divorced from professional contact with the clientele is not so definitely settled.

In some states, especially in the earlier decisions, the statutory exclusion of laymen, as such, from ownership or interest in dental offices has been declared unconstitutional, on the broad ground that the mere ownership of such a property right in no way so endangered the health, morals or physical welfare of the public as to justify the restriction.

OWNERSHIP OF DENTAL OFFICES RESTRICTED

On the other hand, especially in the more recent cases, there is much authority to the contrary that appears to reflect the present day tendency of the courts; and, as an example of judicial reasoning in this line, the recent Michigan case of People v. Carroll, 264 N. W. 861, comes to hand. The statute involved said:

> It shall be unlawful for any person to practice dentistry or to operate or to be a partner in the operation of, or control as proprietor, manager or otherwise, or to have any financial interest in the proceeds or receipts of or from, other than compensation as employee in the usual course of the business, or to receive any part or percentage of the proceeds or receipts of or from, in lieu of rent or any part of the rent of any room, office, or dental parlor where dental work is done, provided or contracted for in any county of this state, not being at the time a dentist licensed to practice as such in this state and registered in the office of the county clerk of such county as herein provided.

The respondent was informed against for violation of the foregoing statute, the specific charge being that he was a partner in the operation of a dental parlor and was not licensed to practice dentistry as required by the statute. There was evidence that he had been engaged in this work for more than twenty years, and that all dental work performed in the respondent's establishment was done by licensed dentists.

The respondent based his defense on the ground that the statute was unconstitutional for a number of reasons, the contention being, among other things, that its requirement that the owner or operator of a dental parlor be a licensed dentist deprived him of a property right; and that this prohibition of the statute was without justification under the police power, because it did not even remotely promote the health or welfare of the public.

HOW THE COURT REASONED

The trial, however, resulted in the respondent's conviction. An appeal followed, and here the higher court, after noting that the regulation of the practice of dentistry was within the police power of the state, turned to the respondent's principal contention. Here, in stating the question before it, the court said: "The next question that presents itself to us is the validity of a regulation requiring the owner or operator of a dental parlor to be a licensed practitioner." Then after reviewing and citing from the leading cases for and against this proposition, the court continued:

> It is a well-known fact that in the profession of dentistry the services rendered are personal and call for knowledge in a high degree, and that to separate this knowledge from the power of control is an evil, the correction of which was attempted by the instant legislation. The evils which arise from divorcing the "power of control" from "knowledge" apply with equal force to a partnership as well as a corporation.
>
> . . . the general rule is that it is within the police power of the state to impose reasonable regulations relative to the professions of law, medicine, and dentistry. Courts distinguish between professions and businesses. In the latter, individuals may engage in the common occupations of life, and laws which unnecessarily impair these rights must be held unconstitutional; but in the practice of a profession such as dentistry which has to do with personal privacy and where the licensee must possess skill and character, we think it is within the police power of a state to control and regulate the ownership and operation by a firm of a dental parlor as well as to prescribe the qualifications of those who engage in its practice. . . .
>
> We, therefore, hold that respondent being engaged in the operation of a dental parlor was engaged in the practice of dentistry contrary to the above act. Judgment of conviction is affirmed.

CONCLUSION

The foregoing case constitutes perhaps the clearest presentation of judicial reasoning upholding the validity of statutory regulation in respect to the ownership of property rights in dental offices that has been handed down to date; for, in the main, prior authority supporting the ruling herein has applied to cases involving the corporate practice of law, medicine or dentistry, under various forms and guises, and has not necessarily dealt with the precise question of ownership regulation.

In this case, however, the court squarely upheld a most sweeping statute prohibiting lay ownership, apparently under any form or pattern, of property rights in dental offices. And although, as noted in the beginning, there is authority to the contrary, the reasoning herein is in accord with the general trend of judicial pronouncements that tend to support and broaden the field of statutory regulation of the practice of dentistry.

1520 East Tenth Street.

BUREAU OF PUBLIC RELATIONS

DENTAL HEALTH EDUCATION AND SERVICE FOR THE CHILDREN IN HAWAII

IN 1914, the Honolulu Dental Society started a dental clinic at Paloma Settlement. The dentists volunteered their services. In March 1915, the Paloma Settlement organized the clinic on a pay basis and employed one dentist. Later, the service was enlarged to two mornings a week. It was closed in 1921.

In 1920, Mrs. George R. Carter (Helen Strong) established, as a memorial to her parents, the Honolulu Dental Infirmary for Children. It received its charter in August 1920 from the territorial government. At first, the staff consisted of one dentist, one hygienist, an acting director, a social service worker and a clerk. The staff was enlarged during the period of 1920-1924 by the addition of three more dentists. In 1922, the dental hygienist's salary was discontinued, as at that time the government replaced hygienists in the public schools. (Fig. 1.)

The charter of the Honolulu Dental Infirmary was amended December 20, 1924, its name being changed to the Strong Foundation, January 31, 1925.

The infirmary was discontinued, and its successor, the Strong Foundation, became affiliated with the Paloma Settlement. The foundation agreed to contribute $18,000 annually provided the city and county would contribute $3,000 annually for supplies. These contributions have been increased until, in 1935, they were as follows: Strong Foundation, $33,575; city and county $3,600; fees from patients, $2,300.75; miscellaneous revenue, $400.00; Paloma Settlement pro rata of $5,322.98, to cover administration and maintenance expense; total $48,617.77. The staff now consists of a director, dentists, office manager, desk clerk, three attendants and a janitor.

In 1935, 9,318 children made 34,622 visits to the clinic. Only children who are certified by the social service worker are cared for. The clinic cares for indigent children up to and including the fifth grade.

HAWAII DENTAL HYGIENIST TRAINING SCHOOL

The Hawaii Dental Hygienist Training School, opened in September 1921, is patterned after the Bridgeport, Conn. plan. Alfred C. Fones helped inaugurate the course. The original course was one year in length. Three classes, 1922, 1923 and 1924, were graduated, which temporarily supplied the islands with a sufficient number of hygienists. The school was closed in 1924 and reopened with a two-year course in 1926 in the Territorial Normal School. The Strong Foundation provided the funds to maintain the hygienist training school. Three classes were graduated in 1928, 1929 and 1930. In 1930, the school was again temporarily closed as the supply of hygienists was sufficient.

It was reopened with a four-year course September 1, 1930, at the Teachers Training College. A fifth year is optional and fifth year graduates are given

preference. The Strong Foundation contributes $5,000 annually to its support.

Entrance requirements are the same as for others who matriculate at the University of Hawaii. The first two years are devoted to a basic cultural and scientific background. The junior and senior years are devoted to dental hygiene. The fifth year (postgraduate) is devoted to health education, and to broadening the general educational background.

Students who have successfully completed the four years' work are granted the degree of bachelor of education and are eligible to take the territorial examination, which, if passed, permits them to practice dental hygiene in the Islands. Students who successfully complete the fifth year receive the fifth year teachers' diploma.

Fig. 1.—Dental hygienist in Hawaii.

DENTAL HYGIENIST IN PUBLIC SCHOOLS

Section 1 of the Hawaii Dental Hygienist Law passed in 1922 reads as follows:

The Department of Public Instruction is hereby *authorized* and *instructed* to engage, at proper salaries, dental hygienists to perform preventive dental hygiene work in the public schools of the Territory of Hawaii and a supervising dental hygienist to have general charge of said work, such employment, however, not to begin prior to September 1922.

One supervisor and nine hygienists were employed the first year. Prophylactic treatments were given children in the first two grades, mouth examinations were given children in the first four grades. Lectures and toothbrush drills were given to as many grades as time would permit.

At present, twenty-five dental hygienists are employed in the public schools. All children in the first four grades in the public schools of the territory are given a prophylaxis and an examination. All children in the fifth to the eighth grades are given a dental examination. Sixty-five thousand children in 163 schools on the inhabited islands are reached with this service.

The equipment is portable. Each hygienist revisits her schools periodically, after she finishes her work in a school, thereby keeping in close contact with each school throughout the year. Definite records of each child show the annual improvement.

Dental health plays, poster making, story writing, play writing, motion pictures, health parades, honor rolls, clean

and 100 per cent seals, room certificates and school banners are used to create interest. Geography, arithmetic, hygiene and language study are interwoven with dental hygiene. The first school on each island to achieve the 100 per cent dental correction banner is awarded a silver cup by Mrs. George R. Carter.

The hygienists work with the parent-teacher association and other community groups. On passing the territorial board examination, they are granted a dental hygiene certificate which is comparable to the elementary first class certificate for teachers, which must be renewed every three years. A life certificate is granted after six years of service provided the holder has completed twelve or more units in an accredited college or university.

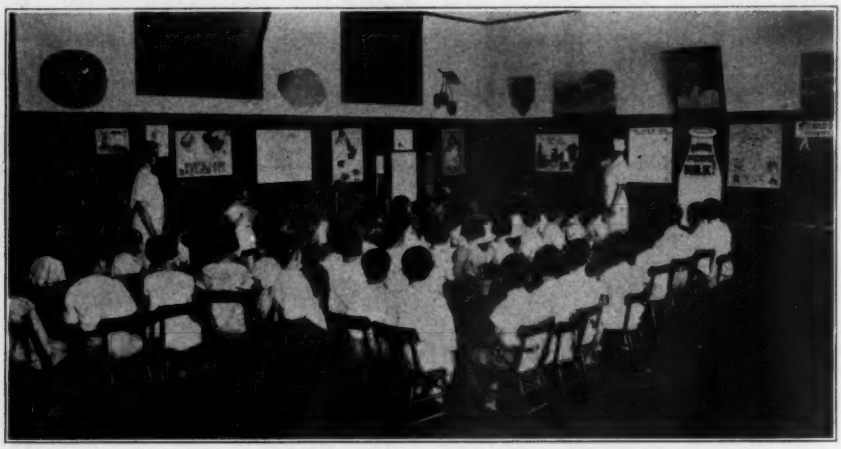


Fig. 2.—Teaching dental health to Hawaiian kindergartners.

SCHOOL DENTISTS AND SELF-SUPPORTING SCHOOL DENTAL HEALTH UNITS

In 1925, the legislature appropriated funds for the employment of four dentists to serve in rural elementary schools beginning January 1926.

In 1927, an additional full-time dentist and a half-time dentist were employed. By means of portable equipment, dental health service was given the children in the first two grades. Emergency service was given in other grades. This work was discontinued in 1932 for reasons of economy. Since then, there have been a number of self-supporting clinics put in operation in the rural schools.

In September 1930, a part-pay self-supporting clinic was inaugurated in the McKinley High School in Honolulu. All children were given a dental examination and emergency service was provided at a minimum cost to children who could not afford the service of a private dentist. The service consists of prophylaxis, simple fillings and extractions.

A plan was worked out with the dental society whereby this service did not interfere with any private practitioner's practice. In the McKinley High School, one full-time hygienist and one-half time dentist are employed. All money collected from patients is turned into the main school office. Supplies, equipment and salaries are paid from this fund. All surplus is retained in the dental fund.

The success of the McKinley School Clinic plus the discontinuance of the

school dental service caused other self-supporting school clinics to be established. At present, there are four such clinics in Honolulu, two in rural Oahu and one in Hilo.

Plans are now under way to establish dental clinics in the plantation hospitals and medical centers to provide dental care for children and perhaps the adults on low wages in the rural areas.

KINDERGARTEN DENTAL SERVICE

Hawaii kindergartens are supported by private and welfare funds, not by the department of education. A dentist and dental hygienist are employed by the kindergarten and children's aid association in Honolulu. Equipped with portable outfits, they travel from one kindergarten to another. Although small fees are charged, the income does not meet expenses. All dental records are turned over to the public schools as the children enter first grade and are used by the public school hygienist.

CATHOLIC SCHOOL DENTAL SERVICE

Prior to 1933, with the exception of dental service rendered the 100 children in the Kalihi orphanage, no dental service was rendered in the parochial schools.

Through the interest of the Catholic Women's Aid Association in 1933, a dental clinic was installed. This operates a few hours each day. Eight dentists give two hours each week. A fee of 25 cents a year is charged each patient who can pay that amount. The work is confined to the indigent children in the eight Catholic schools in Honolulu.

In 1934, a half-time dental hygienist was added to the staff. A fee of 25 cents a patient is charged and the proceeds the hygienist receives as salary. Her services are available to all children enrolled in the Catholic schools.

The Catholic Women's Aid pays for all supplies, transports the children from the schools to the clinic and is responsible for the entire dental program. These women volunteer their services.

Fig. 3.—Representatives of classrooms holding room 100 per cent certificate. Others in the picture are S. Miura, who is referred to as "our school dentist," Elizabeth L. Heen, principal, M. I. Conner, director of the Palama Dental Clinic, who was the speaker at the exercises, Adeline Rodrigues, dental hygienist, Henrietta Austen, health teacher, a classroom teacher from each grade level, Gus Webling, supervising principal of Rural Oahu Schools, Myrtle Holmstad, whose class has had 100 per cent dental corrections for the children in her room for three consecutive years, Theodore R. Rhea, director of health education, Department of Public Instruction and Helen M. Baukin, territorial supervisor of dental hygiene, Department of Public Instruction, and a grandmother of one of the children enrolled.

TIME, TIDE AND TEETH*

By Charles A. Sweet, D.D.S., Oakland, Calif.

Part 1. Time.

THANK you, Mr.——. From your dentist, you have heard the familiar phrase "Open your mouth, please." You and your children, usually with some reluctance, comply with this request. For the next few minutes, I am your dentist, and, being true to character, my request is "Open your mind, please."

It is time for us to be concerned about the mouth, which is the gateway to the human body. Through this portal, at least seven out of every ten diseases gain an entrance to our bodies. The results of these invasions constitute a great catastrophe to our mental and physical well-being and are a most important factor in our financial security. A continual warfare is going on between the body and infection. The mouth as the first line of defense should receive careful consideration and intelligent and adequate care.

It is now time to consider carefully the problem of dental disease in childhood. Ninety-five per cent of the children in the United States need immediate attention. Dental surveys have disclosed that there are about six oral cavities per child, with more than three abscessed teeth per individual. A dental authority, the late Dr. C. N. Johnson, has said "To detect cavities and fill them when they are small does something more than limit the decay in the teeth thus treated: it lessens the tendency to decay in other teeth in the same mouth."

It is time for us to observe the old proverb "An ounce of prevention is worth a pound of cure." Therefore, all children from 2 years of age up should visit the dentist regularly.

"Good morning" in the practice of dentistry has a special meaning for your child. It is the time of day that the child is in the most receptive and cooperative frame of mind, the time he will be far more tolerant of all new experiences. It is the time of day that your dentist is at the peak of his efficiency. His cheerfulness, kindliness and patience are at a maximum. Therefore, children should go to the dentist on week day mornings or the first thing in the afternoon, not after school or on Saturdays. Better dental work is done for your child during these morning hours and more work will be accomplished by your dentist in a given amount of time, which means less expense to you.

Part 2. Tide.

Just as the tide will come in, dental disorders will eventually occur in the mouth unless the Goddess of Luck is with you. You, no doubt, wonder why this misfortune will befall you when you are living in such an advanced, enlightened and intelligent age. Medical science has, through prevention, practically eliminated many of the more serious diseases, such as tuberculosis, smallpox and diphtheria, yet dental disease is on the increase.

Scientific investigation has shown that a balanced diet, containing goodly amounts of milk, orange juice and leafy green vegetables, is advantageous to one's physical growth and development. These balanced diets have been supplemented

*Radio talk given for the California Parent-Teacher Association.

with extracts and concentrates such as calcium and cod liver oil in capsule, pellet or liquid form. Some of our prepared cereals are shot out of guns, burst or predigested, so that they will be more easily assimilated by the body. While these advances have been made to benefit mankind physically, little or no thought has been given a substitute to good old fashioned chewing. As yet, dental science has not been able to find a substitute for this form of dental exercise, which stimulates the gum tissue and brings about a generally healthy oral condition.

Teeth and gums are soft today because they have been "coddled." They are not allowed to function as they were intended to by Nature. For soundness and beauty of teeth, chew an apple instead of swallowing applesauce; chew a beefsteak instead of eating ground-up meat, and eat an orange instead of drinking orange juice. One of the essentials to mouth health is the preparation of foods so that mastication is a necessity. Refinements and substitutions for natural foods proceed with civilization; therefore, dental disorders will be on the increase unless similar artificial substitutes are found to stimulate and cleanse the mouth.

The toothbrush, dentifrices, mouth washes and dental floss have been developed as aids to eliminate dental disease. Sufficient recognition has not been given these very worthy products by the general public. There are more automobiles in the United States today than there are toothbrushes. It seems almost unbelievable that there should be such a lack of interest in mouth health and cleanliness. De Paul University's research expert, L. M. McDermott, has annually for the last six years quizzed 10,640 Chicago families to learn what they would like to buy next. His predictions have been borne out consistently by later buying figures. Last month, he asked his question again, and found vacuum cleaners first choice, automobiles second, furnaces thirty-eighth. Medical and dental care was in the plan of none of the families questioned.

We must use these weapons of defense because they help to inhibit the growth of bacteria, a factor in all dental disease.

The child should use an ordinary sized toothbrush having hard bristles and applied with plenty of "elbow grease," or vigor, at least after breakfast and just before retiring if the present-day coddling is to be counteracted.

The ability of an individual to utilize the vitamins, minerals and other substances taken into the body helps to assure that sound and healthy teeth will be developed and maintained. It is one thing to ingest these necessary substances and quite a different thing to have them absorbed and carried by the blood stream to the different parts of the body.

During adolescence, which is about the twelfth to the sixteenth year, the teeth have a greater susceptibility to decay, even though every care and precaution may be taken. Only a comprehensive physical examination by a well-trained, alert physician can detect certain physical imbalances, such as failure of some of the glands to start functioning, or the presence of low-grade chronic infection harbored by the sinuses, tonsils or appendix. These conditions frequently are responsible for a lowered resistance of the entire body. The mouth as a part of our bodies is affected by this lowered resistance.

During adolescence, the child is in need of more consideration and care by the physician and dentist than at any other time of his life. The fact that he appears to be physically well does not mean that he can do without physical guidance and not pay a penalty sooner or later in his life.

Today, eight out of every ten children born into the world live to adult life. Fifty years ago, only five survived. It is no longer the survival of the fittest, but the survival of the medically fit. This 60 per cent increase in the number of those

who live because of the advances in the medical sciences means that many with physical irregularities survive. Just as long as there are these advances in our scheme of living, we must anticipate more and more physical imbalances; but this does not justify our failure to utilize all known procedures to protect ourselves against the tide that may carry us so far that rescue is impossible or that we are handicapped for life.

Be true to your teeth or they may be false to you.

Part 3. Teeth.

Teeth are the hardest substance in the human body, yet they are very susceptible to destruction. This is not an inherited tendency, as we inherit only the shade and shape of the teeth. Each individual builds his own permanent teeth. Most of you think a cavity in a tooth is quite harmless except that it may be painful; but that is not the important fact. In a cavity, or hole, in a tooth, there are no disease-producing bacteria that one can name that cannot be dug out of that cavity and grown in sufficient numbers to kill an entire army.

When the very best of food, prepared in the most acceptable manner, is ground or chewed up by teeth that have cavities in them, this food is actually dirtier than if it had been dropped on one of our public highways. On the highway, there is fresh air, sunshine, rain and snow to destroy disease-producing bacteria.

I wish to remind you again that there is an average of more than three dental abscesses per child draining into the mouth, mixing their products with food as it passes into the stomach to be absorbed by the blood stream.

If we had such a contamination of our water supply as this, we would not try to correct or eliminate it by putting filters on every faucet in the home. We would go to the source of this contamination and purify it. The same procedure should be followed out with the child by eliminating the source of the infection, decayed and abscessed teeth.

One's appearance is sometimes the thing that brings success or failure. The number of crooked teeth is increasing mainly owing to lack of vigorous use of the teeth and jaws coupled with physical imbalances and glandular peculiarities.

I should like to tell you a little about the late "Chic" Sale, whose father was a dentist in Urbana, Ill. When Chic was about 12 years of age, his father took him into his office and proceeded to try to interest him in dentistry, but Chic was more interested in the queer whimsical characters of the Midwest who visited the office. He began making artificial sets of teeth which he could slip over his own, and to practice imitating the manners of speech and dress of these patients. With this equipment he later made a tremendous success on both stage and screen. Chic Sale's whole stock in trade was appearance.

If you should decide to try to enter motion pictures, the first thing they would do is to take a picture of you. If you should have any facial defects or crooked teeth, all these imperfections would have to be corrected so that your appearance would be as nearly perfect as possible.

The late Lon Chaney was the greatest character actor that the stage or screen has ever known. He had ten or twelve artificial sets of teeth which he could slip over his own, so that he might portray those characters that sometimes made a chill run up and down your spine, or yet again brought laughter. Lon Chaney has been credited with saying that there is many a capable mind that is hidden behind a hideous face.

It is a well-known fact that inferiority complexes are sometimes due to the fact that the teeth are unsightly. A pleasant, cheerful smile takes one a long way on the road of success and adds much to one's confidence and self-assurance.

When these benefits for the child are

within the grasp of all, it is sad that unnecessary things are placed first and we find no place in the family budget for dental care. No amount of legislation can force people to see their dentist twice a year, and hand-outs of all kinds are utterly demoralizing. Only through the avenues of education will every child come to have the advantage of growing up without the defects that modern science can correct. The parent-teacher associations are deserving of a lasting tribute for fostering health programs in our schools.

AN ORAL HEALTH PROGRAM FOR HIGH SCHOOLS

By Irwin Walter Scopp, B.S., D.D.S., New York City

THE condition of the "dental cripples" spoken of in current advertisements develops during adolescence, the period when the ravages of dental decay are most active and pernicious. The treacherous part of this decay is the speed with which it progresses without letting its host know of its existence. Usually, when pain occurs, it is too late and the ailing tooth has to be extracted. Dental caries, or decay, can aptly be compared to cancer in its speed and detrimental effects. Only too late does the victim become aware of its existence.

Dentistry, however, has advanced a step farther in conquering dental caries than Medicine has in dealing with cancer. We can anticipate with a good deal of certainty where decay will occur. For example, we know that fully 95 per cent of children 16 years of age will have either a cavity or a filling in a first molar or will have lost one of these teeth, owing to a development defect on the tooth. Furthermore, all this can be prevented by treatment. In short, for children, prevention should be the crux of dental care rather than reparative and restorative dentistry.

The following program outlines an adequate set-up for dental care during high school age. The program consists of dental health education, dental care for children of families of average means and dental care for indigents.

I Education

1. What should be taught:
   - (a) Relation of mouth hygiene to physical health.
   - (b) Facts on mouth hygiene.
   - (c) Method of toothbrushing.
   - (d) Choice of dentifrices.
   - (e) The fallacies in dentifrice advertising.
   - (f) The limits of home care and use of dentifrices.
   - (g) Dietetics in relation to oral health.
   - (h) Preventive dentistry in lieu of reparative dentistry.
   - (i) The appearance of a healthy mouth.
   - (j) Care of gingivae.
   - (k) Pyorrhea.
   - (l) Vincent's infection (trench mouth).
   - (m) Systemic disease manifestations in the oral cavity.
   - (n) Injurious mouth washes.
   - (o) Importance of baby teeth.
   - (p) Common misconceptions regarding dentistry.

(q) Means used to avoid pain in dentistry.
(r) Dental first aid.
(s) Fractures and dislocations in the mouth.
(t) What to do in case of a toothache.

2. Who shall teach:
(a) Dentist or oral hygienist who has been trained in pedagogy.
(b) The dentist or hygienist who is a full-fledged teacher in the department of health education.
(c) Not regular biology or health education teacher who has only a smattering knowledge of dental health.
(d) Teacher with ample models, charts, motion pictures available to adequately present material.

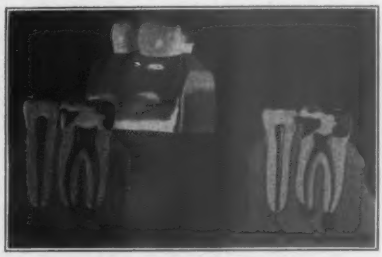
II Periodic check-up and follow-up:
1. Every pupil in school should be examined by a dentist every term.
2. Pupils should be referred to family dentists for work.
3. Special and doubtful cases should be examined by the school dentist.
4. No teacher or other lay person on the school staff should be entrusted with mouth examination of pupils. Only a licensed dentist is capably trained in rendering a satisfactory examination.
5. In special cases, report should be be made to the dentist oftener than every term in order to detect incipient decay.
6. Care should be taken to avoid the "paternal" dentist who gives "o. k." notes to pupils without examination or with merely a cursory examination.
7. Certain types of pupils will avoid dentists and use all types of chicanery and evasion. Some are told by their parents that filling teeth is worthless. Others by their very natures will try to "put something over." Usually, these are the very ones that need dental care most.
8. An adequate follow-up system should be instituted. These may entail conferences of the family, dentist, physician, health counselor and teacher.
9. A card should be filed for each pupil during his first term and records made each term of the number of fillings, extractions, prophylaxes, etc. Such records for a large group are virtually nonexistent. They are priceless for research. They render the student a fine service in showing him his own dental condition. In many cases, such records lead to corrections in dietary, toothbrushing and other habits. These records also serve to emphasize to the pupil the importance of meticulous care of the teeth and gums.

III Provision for indigent pupils.
1. Service rendered should be complete, including preventive, reparative and restorative work. An orthodontic and prosthetic service should be available in special cases.
2. Such a service should be completely financed by government funds.
3. The student should not feel his is a charity case.

The benefits in oral health and general physical well-being and improvement in individual hygiene and the general psychologic make-up of the child warrant this program.

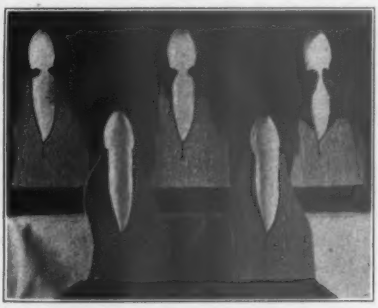
DENTAL EDUCATIONAL MODELS—SERIES A

NEW light latex models especially designed for teaching and display purposes, we believe, solve the model problem. Latex will not break, crack or chip. Each model is about 12 inches high, yet so light that the frailest child can handle it. This particular set—Series A—are reproductions of models made by the members of the Springfield (Ohio) Dental Society. They are for rent or sale by the Bureau of Public Relations, American Dental Association, 212 East Superior St., Chicago. Models A-1, 2, 3 and 4 rent for $1.50 per week; models A-5 for $3.00 per week. Send for a catalog of dental educational material.

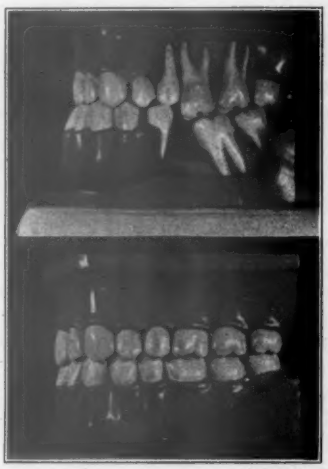


A-1: Three 12-inch latex models showing value of x-rays in revealing proximal and other hidden decay.

A-4: Two 12-inch latex models showing value of x-rays in revealing impacted teeth.



A-2: Five 12-inch latex teeth showing progress of pyorrhea.



A-3: Two 12-inch latex models showing value of x-rays in revealing root fragments.

A-5: Four 12-inch latex models (two sets) showing changes that often occur after extraction of tooth.

DENTAL ECONOMICS

A DENTAL INTERNSHIP

By L. H. Shipman, D.D.S., Worcester, Mass.

Why take a dental internship?

Why waste a valuable year?

What is the incentive in working with little or no financial remuneration?

Why is it that more graduates do not take internships if they are so beneficial?

Are men with internships more likely to receive advancement?

This paper is more or less a report on a year's dental internship.

An internship defers the cost of equipping the office for a year, which is often advantageous. The intern's necessities cost him very little. The major objective for the intern is, or should be, the unlimited, important and varied experience offered.

Let us outline the typical day for the dental intern in a large hospital. He rises at 8 o'clock and "makes the rounds"; i.e., visits all his patients on the service, checking on temperatures, changing dressings, etc. After breakfast, he goes to the outpatient department, where, in the course of the morning, from twenty to sixty patients are cared for. All work for the ambulatory patients is done here, under the supervision of the visiting dentists who have been appointed by the hospital trustees to the dental staff, and whose duty it is to instruct and to demonstrate, and to help the intern. From the visiting men, the intern receives much knowledge in theory, instrumentation technic and that side of the profession seldom taught in school. Here in the outpatient department, the intern does many things, namely extractions, apicoectomies, alveolectomies and flap operations (window operations); treats Vincent's infection and pyorrhea (surgically), gives follow-up treatments for fractures; orders and reads x-ray films; consults with medical interns; writes prescriptions, etc. He follows most meticulously a sterile technic. Autoclaved gloves, gowns, towels, sponges, etc., are used. In the outpatient department, with the assistance of a nurse and an oral hygienist, he is able to keep data on many and varied subjects; e.g., the efficiency of postoperative obtundents, the degree of postoperative pain experienced with cowhorn as compared with other lower molar forceps, the results of apicoectomy, the efficiency of various sutures and knots and the efficacy of different methods of ligating fractures. In short, he determines the technic, materials and procedures that will be most efficacious in his own practice.

The intern goes to lunch where, as one might expect, "shop" is the chief topic of conversation. Of course, owing to the greater number of medical men present, the subject is usually appendectomy, bilateral oophorectomy, reduction of compound fractures, etc. These subjects, however far from the field of dentistry they may be, show the dental intern how the medical men think, plan, compare and act. His medical nomenclature is increased to such an extent that when conversing with a physician he does so with ease, which only the experiences of an

internship can assure. The dental intern finds his place in the institution, and realizes his limitations and the benefits that his profession can render to mankind.

After lunch, he makes the rounds with the visiting dentist, at which time the cases are discussed and dressings changed, progress is noted and treatment changes are made. The nose and throat service is in close contact with the dental service, the medical intern making the physical examination, taking the history, writing orders, etc., during the first few weeks. As he becomes more acclimated and when he has had sufficient experience, the dental intern takes over most of these duties, but he is still working with the nose and throat service. "Working with" is one of of the most important lessons that the intern learns. One may have the desire to work with the other dentists and medical men, but often is unable to do so harmoniously, for lack of experience.

The dental intern may now go to the surgery, where he dons surgical cap, mask and rubber apron and "scrubs up" for ten minutes. A nurse pours alcohol on his hands, which he dries with an autoclaved towel. He is helped into an autoclaved gown and removes an impacted cuspid or third molar; or he reduces a fractured edentulous mandible under avertin, which he may have helped to prepare and administer.

Now we follow him to the ward where an old arthritic patient has many infected teeth. The dental intern has learned to extract teeth for a recumbent patient; so here again he operates with poise. He leaves orders for the treatment of postoperative pain and sleeplessness. Knowing that the usual 10 grains of acetyl salicylic acid prescribed by the average dentist does very little to alleviate pain, he leaves instead an order for codeine 1 grain with acetyl salicylic acid grains 10, as needed, every four hours. While he is writing the postoperative orders for the infectious arthritic case, he has a call from the accident floor where a child is suffering from an abscessed upper deciduous molar. He orders atropine and calls for an anesthetist. After the child's physical condition is determined by a medical intern, she is anesthetized just deeply enough to relax the jaw and insert a mouth prop and throat pack. After the extraction, the intern tells the parent that the child may be taken home within three or four hours. He instructs the nurse to keep the patient face down to avoid inhalation of foreign matter and, if bleeding does not cease, to have the patient bite on sterile gauze.

After the evening meal, the intern makes the rounds of all patients on the dental service, including any others for whom he has worked.

After one has administered a sufficient number of general anesthesias under the supervision of the chief anesthetist, he is certified to give anesthetics without aid; and so the intern goes to administer nitrous oxide and ether to a patient with acute appendicitis. Here again, he works *with* others, trying to keep the patient at the correct depth of anesthesia. If the patient stops breathing and becomes cyanotic, he shuts off the nitrous oxide and administers carbon dioxide and oxygen until the patient is again breathing normally. Here, during major operations, the dental intern observes the poise, manual dexterity, judgment, speed and finesse of the operating surgeon. The intern anesthetist is a part of this vital procedure, and he tries to blend his actions harmoniously and efficiently into the surgical process. After the operation, in the doctor's dressing room, he listens to those accomplished men, compares and analyzes, ever trying to emulate their many worthy qualities.

If, before bedtime, there is opportunity for study, he may go to numerous sources for his information. Here in the hospital, he studies something that he has actually seen. Moreover, he may study what and when he desires.

During the night, he may be called to arrest postoperative hemorrhage. He does so with pressure on sterile gauze (with or without thromboplastin), by use of a suture or by whatever technic he has found most advantageous. If there is considerable pain, due to biting on the gauze, he may, if it is indicated, give the patient morphine one fourth grain. And so back to bed.

Every day may not be so busy as the one through which we have followed the dental intern. He has time for tennis, baseball, football, walks, swimming, sunbaths, moving pictures, etc.

In his spare time, he also has unlimited opportunities to watch necropsies, transfusions, deliveries, reduction of fractures under the fluoroscope, major operations, etc. He may spend much time with the intern who covers the accident floor, where he may learn something about diagnosis, the handling of delirium tremens cases, the indications for the various sutures, treatment of minor burns, removal of foreign bodies from the ear, etc. He may spend his spare time in the pathology laboratory, staining his own slides and studying them with the help of the chief of the pathology department.

He usually has every other evening and week-end off, in which time he may go to his own or a friend's home, where a good home-cooked meal is waiting. In this time, he has the change of faces and environment which is so essential during institutional life.

Let us summarize, at this point, the work accomplished during the year by two dental interns in the outpatient department and among hospitalized patients.

Outpatient (ambulatory patients)

851 fillings (amalgams, synthetic, zinc oxide).

970 treatments (Vincent's, postextraction, etc.).

1,351 examinations (preoperative).

25 apicoectomies (Mead's technic).

5,134 extractions (permanent and deciduous).

7,575 patients treated.

House (recumbent patients)

500 general anesthesias (medical and dental).

25 fractures.

75 acute cellulitis cases.

2,000 extractions.

50 impactions.

I should like to give my impressions and deductions on a number of varied problems that repeatedly arise in dentistry. (If there are any differences in opinion, I should be only too pleased to hear them.)

COWHORN FORCEPS

Some dentists do not use cowhorn forceps, maintaining that undue trauma is caused owing to spreading of the lingual and buccal plates, which results in extreme postoperative pain. In thirty cases in which cowhorn forceps were used twenty-five patients had no postoperative pain; three slight postoperative pain, and two severe postoperative pain.

HEMORRHAGE

Often, in stubborn postextraction hemorrhage cases, when the patient is instructed to "bite hard," there is much pain. It was found that the patients could bite hard with no discomfort after sufficient time had elapsed for one-quarter grain of morphine to become effective.

OSTEOMYELITIS

Oral hygiene is a most important factor in relation to a complicating osteomyelitis in fracture cases.

VINCENT'S INFECTION

The average subacute Vincent's case can be handled with sodium perborate in paste form used as a pack for from fifteen to twenty minutes six times a day.

In acute cases, neoarsphenamine may be used in addition to the perborate. The amount of rest, the diet, etc., should, of course, be prescribed.

PAIN

Pain is relative, having many degrees of severity. Some "pains" can be alleviated with a placebo (sugar and water). Then there is the slight pain which may be controlled with 10 grains of acetyl salicylic acid. For a more severe pain, 1 grain of codeine and 10 grains of acetyl salicylic acid are recommended and, lastly, we resort to morphine one quarter grain.

UNHYGIENIC MOUTHS

Extremely unhygienic mouths are unpleasant to work in and teeth should not be extracted while this condition exists as the percentage of dry sockets and post-operative pain resulting is high. This condition can be eliminated with no effort on the dentist's part if the patient is instructed to pack the gums with sodium perborate paste six times a day for a week. After this home treatment, scaling may be done, and the result is most gratifying. Very few cases of idiosyncrasy to sodium perborate were noted.

INTRA-ORAL INCISIONS TO PROMOTE DRAINAGE

Intra-oral incisions are made only after due deliberation, especially in extensive acute cellulitis in which the infection has progressed to the cervical region.

EXTRA-ORAL INFRA-ORBITAL INJECTIONS

The extra-oral infra-orbital injection is of much greater use than it is given credit for. It has been found most useful in apicoectomy, local cellulitis in which infiltration was contra-indicated and the removal of impacted cuspids.

NITROUS OXIDE

Nitrous oxide is a respiratory depressant and should be used only in competent hands. It is used in the medical profession only after a physical examination. How many dentists take this most necessary precaution? Are there not some who play the most unwise dual rôle of anesthetist and exodontist simultaneously?

SUMMARY

An accredited dental internship (1) minimizes the mercenary side of dentistry; (2) emphasizes service; (3) affords unlimited and varied experience; (4) creates poise; (5) teaches one his personal and professional limitations, and (6) is the ethical, social, practical and conversational connecting link between medicine and dentistry.

311 Main Street.

THE DENTAL WORK PERFORMED AT THE CONNECTICUT STATE PRISON

By H. F. Waldman, D.D.S., Hartford, Conn.

SINCE 1931, a full-time dentist has been in attendance at the Connecticut State Prison. Previously, the dental work was performed by part-time dentists who visited the institution once or twice a week. In 1931, the hospital was reorganized and an attending staff installed. A chief-of-staff was appointed, together with a resident physician and dentist. To the attending staff, there was appointed a surgeon, an opthalmologist and a rhinologist and laryngologist. Since then, the staff has been enlarged to include a protologist and a psychiatrist.

In the beginning, the amount of medical service was small, the facilities were limited and, at times, patients had to be taken outside for treatment. Gradually, the hospital was enlarged and improved, until today we have at the prison a very efficient and modern organization where medical service of practically every type can be obtained.

There are twenty-five beds, each one in a private room, with a large room for convalescing patients, a tuberculosis ward, dental office, x-ray room, large operating room with sterilizing room adjoining, drug storage room and dispensary. In the near future, a roof garden for the tuberculous will be built adjoining the ward. A full-time male nurse is now employed.

Previously to the appointment of a resident dentist, the dental service consisted mainly of extractions and the making of dentures. The extractions and necessary fillings were done at no cost to the inmate. He had to meet the expense of any denture which was made or any inlay which was inserted. Exceptions were made in the cases of inmates unable to pay, the state meeting the cost.

Today, all dental as well as all medical service is free to the patients, although any gold restorations must of necessity be reduced to an absolute minimum.

I should like to tell briefly something of the medical work done at the prison. A daily sick call is held every morning, at which time any inmate wishing to see the physician may appear. Emergencies are taken care of at any time of the day. Appointments are made should it be necessary for patients to see any other doctor on the staff. An inmate who is unable to work is sent back to his cell with a sick-call slip. One needing hospitalization for treatment or observation is admitted at once to the hospital. Drugs are prescribed and treatments given and minor surgical operations performed. An average of forty men are on the daily sick call.

The medical department is responsible for the general sanitation of the institution. It is often called on to treat special conditions such as are due to various types of nervous disorders and the so-called confinement neuroses. It passes on the fitness of the inmate for his job or for any manual work he may do. It also submits reports to the parole board and board of pardons.

The dental department has a very complete and efficient equipment. It also has at its disposal the hospital with its operating room, microscopes, laboratories and sterilizing room.

Each incoming man spends two weeks in isolation, during which time he is examined by the physician and the dentist. All cases of infection are treated at once.

Read before the Hartford Dental Society, March 14, 1938.

If a full-mouth extraction is ordered, the inmate is placed on a special diet for a short time while the dentures are being constructed. In cases of Vincent's infection or pyorrhea, treatment is started at once.

It is the purpose of the dental department to extract immediately all teeth which are hopelessly infected or are so badly broken down that restoration is impossible. For all other work, an inmate desiring dental treatment sends to the office a dental slip signed by the officer under whom he works. These men are called in the order of receipt of the requests. For emergency work, the patient is admitted at once.

As there is an average of 750 inmates, and as the large majority of them desire dental service, it can be seen that the visits must be limited. Nevertheless, for all routine work, each patient is seen once every six weeks. Of course, work started for dentures is carried through to completion without delay. An effort is made to spend at least twenty to thirty minutes with each man and to fully complete at least one operation.

During a two-year period, from July 1934 to July 1936, 6,553 patients were seen, of which 1,523 were merely examined; 1,055 teeth were extracted and 1,786 restorations were made; 1,916 treatments were completed and 336 dentures were made. The treatments include those for gingivitis, pyorrhea and Vincent's infection, postoperative care and prophylaxes. An average of 273 patients were seen each month.

During this time, it was found that each new man had an average of 7.44 teeth missing and 1.91 carious teeth, the latter including only those with very large cavities with pulp exposure or those approaching pulp exposure or having one or more walls broken off. About 11 per cent had Vincent's infection in its early stages and 19 per cent had gingivitis and pyorrhea in various stages. Twelve cases of malocclusion per hundred were found. Twenty-two per cent had ten or more teeth missing, mastication being greatly impaired.

One fact noted in the examination of new men is the definite lack of mouth hygiene in a large percentage of cases.

Quite a number of impacted teeth were extracted, most of them third molars. These were usually removed under local anesthesia, the patients then being hospitalized for a short while. All recovered very quickly.

The dental department must necessarily be closely allied with the medical department for certain cases. The x-ray examination plays a valuable part in this work.

The dental service performed for a patient in an institution of this kind is, of course, the same as is given on the outside; but the individual himself is different. Long confinement sometimes changes a man considerably. He often pays more attention to himself; he magnifies things greatly. Many times, inmates point out slight discolorations on teeth due perhaps to deposits which cannot be removed with the toothbrush. Often, they will go for weeks thinking of some such matter. Then they are given a prophylactic treatment, and immediately things change for them. It is almost as if an immense load is taken from their minds.

In many ways, the inmate's behavior is the same as that of any other patient. Some of them can stand no pain at all. I have seen men from whose conduct outside one would never suspect their fear of anything actually cringe and tremble even to sit in the dental chair. I have seen them faint on the injection of a local anesthetic—faint even at the sight of blood.

On the other hand, I have seen others never flinch nor utter a sound when teeth are extracted with no anesthesia. One man would not let me give him any kind of an anesthetic for the removal of an infected tooth. He sat perfectly still while I extracted a mandibular molar which

was very firmly held in the alveolus. Another man, who had several teeth to be extracted, would come in about once every three weeks for an extraction without anesthesia.

What does the inmate himself think of the dental service? The average man wants to see his "time" pass as quickly as possible; he wants to be left alone and not be annoyed; he is grateful for whatever is done for his welfare, is grateful for the movies, radio, recreation, books and entertainments; but he thinks that maintenance of his general health and dental and medical care are among the greatest services which the authorities can do for him during his incarceration. The inmate is always hopeful, no matter what his sentence. He must have something to look forward to. If he loses hope, everything is lost.

Just what is the value of the dental service?

An authority on criminology has said, "The end and aim of a penal system is the protection of society. Communities are entitled to this protection. They are 'not entitled to vengeance.' "[1]

As early as 1870, one of the Declarations of Principles of the American Prison Association was as follows:

The treatment of criminals by society is for the protection of society. But, since the treatment is directed to the criminal, rather than to crime, its great object should be his moral regeneration. Hence, the supreme aim of prison discipline is the reformation of criminals, not the infliction of vindictive suffering.

Under the reformation, we can mention (1) religion; (2) education; (3) recreation; (4) health measures, and (5) the cultivation of the prisoner's self-respect.

Perhaps the first and most important of the welfare projects in a prison is the medical service, and under this we may include dental service. By meeting the dental and medical needs of the inmate, we also improve his general well-being and help to keep him in that state of mind where time will pass to his best advantage and his morale will at least not be lowered; and we believe that we help to reduce, no matter how slightly, rebelliousness, unrest and dissatisfaction, thus contributing in some way to a successful administration of the institution.

Food is very important to a person confined in prison. If well fed, he is not apt to cause disturbances. But how can a man whose oral cavity, the gateway to the alimentary tract, is in such a condition that he cannot masticate food maintain that degree of health necessary for the enjoyment of life?

One of the first steps toward reformation is to remove sources of infection and physical disability. When these are eradicated, there is at once a change in behavioristic tendencies. There is a parallel between this kind of medical and dental work and the attempt at moral rehabilitation.

A famous prison warden has stated that "every unchecked criminal career is a focus of moral infection and to the extent that we return one of these individuals with the danger of contagion removed, to that extent may we be said to be contributing to a program of crime prevention."[2]

A man leaving an institution with his health greatly improved goes out in a better condition to meet the competition of the industrial system than was the case before his admittance. In this way, a public service can be rendered.

The true extent of the relationship between physical and mental infirmity and crime has not been established. But is it not reasonable to suppose that, by improving one, the other will be improved to some extent?

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NEWS ITEMS OF INTEREST

U. OF M. GETS GIFT FOR DENTAL SCHOOL

THE UNIVERSITY OF MICHIGAN Wednesday announced acceptance of a gift of $236,500 from W. K. Kellogg Foundation, of Battle Creek, to be used in construction of a school for children's dentistry.

A prediction that the gift will enable the University to pioneer in graduate and post-graduate dentistry as well as additional research in orthodontics and dental caries was made by Dr. Paul H. Jeserich, of the University Dental School.

Added to the Kellogg gift will be a WPA grant of $193,500. The total of $430,000 will be utilized to construct a three-story building which will be known as the W. K. Kellogg Foundation School of Children's Dentistry.—*Detroit Dental Bulletin,* October 1938.

BAR LEARNS HALF OF ITS MEMBERS DO NOT MAKE $2,000

NEARLY half the lawyers in the United States earn less than $2,000 a year, according to a survey published yesterday by the American Bar association. Less than 2 per cent of those in the profession have incomes of more than $15,000 a year.

The report was prepared by a special committee of the association, headed by Lloyd K. Garrison, dean of the University of Wisconsin law school. Mitchell Dawson of Chicago was a member of the committee.

The findings indicated that a large number of lawyers are unable to earn a living in practice and that many young lawyers cannot find openings. Low cost legal service bureaus would create more work for lawyers, the committee said.—*Chicago Tribune,* October 10, 1938.

WILLING TO SUPPORT PREPAYMENT PLAN FOR MEDICAL SERVICE IN WISCONSIN

BASIC reforms designed to bring better medical care at lower cost to the people of Wisconsin were adopted by the State Medical Society of Wisconsin late Tuesday.

The delegates unanimously voted to put into effect the statewide hospital insurance plan proposed by the committee headed by Dr. Stanley Seeger, Milwaukee. The forty-two specific reforms proposed by the committee on medical care were adopted by a majority vote after several hours of discussion.

Approval of the report pledges the society to support voluntary sickness insurance programs in Wisconsin, as well as hospital insurance as proposed by Dr. Seeger's committee.

Sickness insurance plans are designed to provide complete or partial medical care for individuals or families for a fixed monthly payment. No recommendation as to the monthly fee to be charged under society sponsored plans was made by the committee, although it condemned the $3 monthly family fee now commonly used as "grossly inadequate."

The delegates also voted to appropriate $7,000 to help set up sickness insurance plans during the next year in any area "where public interest is sufficient to insure a possibility of success." These plans will be under the supervision of local county medical societies and under the control of joint committees composed of an equal number of doctors and lay advocates of the plan.

All details of specific plans will be determined by joint committees of this type, but all the projects will be underwritten by the state society to insure adequate care for the sick even though the premiums prove insufficient.

Dr. James C. Sargent, Milwaukee, retiring president of the society, pointed out that the medical profession could make no promises regarding the success of the proposed experiments, but would do its best to assure their success.

"In our efforts to further the care of the sick the medical profession will try proposals suggested by both doctors and laymen," Dr. Sargent said.

There will be no more than three initial experiments and they will be limited in scope. If the original experiments prove satisfactory, it is proposed to set up others until eventually the entire state will be served.

Solicitation costs and profit to the management will be forbidden and administrative costs will be pared to a minimum, it is planned.

Appropriations from the state will be asked to provide adequate medical and hospital facilities for poorly populated northern Wisconsin counties; to increase the staffs of state health institutions; to extend medical relief facilities; to raise state health officers' pay, and to assure an adequate program for the correction of defects revealed in surveys of school children.—*Milwaukee (Wis.) Journal,* September 14, 1938.

COLLECTION FRAUDS

WATCH out for the wave of gyp collection agencies that offer to collect long-overdue bills for professional men. A glib representative proposes to collect all accounts receivable at easy terms to the debtors, produces "letters of satisfaction" from other clients, and may even advance a small sum against future collections. It isn't until the company has collected the cream of the accounts—and kept all the money—that a statement is sent to the client. With minimum charges, charges on bad accounts, service charges, etc., the statement shows that the client owes the company money. There's little recourse to law because the client has signed an ambiguous contract which often is submitted for his signature merely as an "application" or "listing sheet."—*Newsweek,* October 10, 1938.

DENTAL PROGRAM

THE dental program in the public schools of Peoria, Ill., financed by the Board of Education from the educational fund, was carried on at an annual expense for the academic year 1937-1938 of $12,430. This is an annual per capita of $0.55 for each child enrolled in the schools. An analysis of work done reveals the following:

19.86 per cent of the pupils examined had mouths in good condition, needing no present dental attention.

21.13 per cent were under the care of their own dentists, with dental service practically completed.

14.01 per cent were having opportunity for service in the school dental dispensaries.

55.00 per cent, the sum of these three items, represents the per cent of pupils coming under the benefits of dental health appreciation.

45.00 per cent were apparently able to pay for service and were referred for attention to dentists of their own choice.

In addition to actual care, an extended dental health education program is carried on in grades two to eight inclusive. As a part of this educational effort, 69,682 pieces of material were distributed by the department; there were 190 classroom talks, and 348 poster exhibits mounted. (Annual Report 1937-1938 Peoria Public Schools, Dental Department, C. Carroll Smith, D.D.S., Director.)—*Journal of School Health,* October 1938.

DENTAL HYGIENE COURSE

A TWO-YEAR course for dental hygienists replacing the present one-year curriculum has been authorized by the regents of the University of Michigan. The new course will offer training in technical procedures with a view to making the hygienists more useful as assistants to dentists, and will transfer the instruction in anatomy, bacteriology and chemistry from the dental faculty to the regular course given for nurses.—*New York Journal of Dentistry,* July-August 1938.

PUBLIC SERVICE

WASHINGTON, D. C.: A Public Health Service dentist is to tour isolated regions of the Great Lakes in an automobile trailer to clean up the molars of Coast Guardsmen and other Federal employes.—*Newsweek,* October 10, 1938.

CURRENT LITERATURE

Cold Vaccines

By H. S. Diehl, A. B. Baker, and D. W. Cowan

Cold-susceptible students of the University of Minnesota were used as subjects for a carefully controlled study of the value of three different vaccines which are recommended for the prevention of colds.

A "control group" was observed during each year of the study. Such groups were chosen at random from the students who applied for cold prevention treatment; the members were treated in exactly the same manner as those of the vaccinated group, and they believed throughout the period of the experiment that they were receiving vaccine. Sterile physiologic solution of sodium chloride was administered hypodermically as a control for the subcutaneously administered vaccine and lactose-filled capsules as a control for the vaccines administered orally.

One of the most significant aspects of this study was the great reduction in the number of colds which the members of the control groups reported during the experimental period as compared with the number that the same students reported for the previous year. In fact, these results were as good as many of those reported in uncontrolled studies which recommend the use of cold vaccines.

The group which received vaccine subcutaneously experienced an average of 25 per cent less colds per person than did the control group. This difference occurred during both years of the study and is satisfactorily significant. Practically, it is of little or no importance, because a reduction of 25 per cent in the average number of colds in a group is not sufficiently great to justify the time and expense involved in carrying out the intensive vaccination procedure which was utilized.

The group which received the polyvalent vaccine administered orally experienced just as many colds as the control group during both years of the study.

The results reported by the students who took Rosenow's streptococcus vaccine parallel exactly those reported for the control group.

Although the data are not entirely conclusive, there is no evidence in this study either that vaccines reduce the complications of colds or that the condition of the nose and throat is related to the frequency of colds in a cold-susceptible group.

The vaccine selected for this study was standardized according to the milligrams of nitrogen per cubic centimeter as follows: pneumococci, 0.015 mg.; streptococci, 0.015 mg.; *Bacillus influenzae*, 0.01 mg., *Micrococcus catarrhalis*, 0.0025 mg., and staphylococci, 0.0075 mg.—*J.A.M.A.*, 111:1168, September 24, 1938.

M. K. Hine.

Safety of Dental X-Ray Exposures

A dental x-ray equipment giving 10 milliamperes was tested for output in roentgens. There was a filter of the bakelite case of the box enclosing the tube as well as the layer of oil surrounding it. The measured dose was 2 roentgens per second when the focal spot of the tube was about 7 inches from the skin of the face. As the average exposure for a molar is ten seconds, the dosage would be about 20 milliampere-seconds for a molar. About half that would suffice for an incisor. The maximum safe exposure over any given skin area with the dental equipment described under the conditions named would be 200 milliampere-seconds.—Queries and Minor Notes, *J.A.M.A.*, 111:1040, September 10, 1938.

M. K. Hine.

Hairy Black Tongue

Hairy black tongue (nigrities, hyperkeratosis) is a hypertrophy of the filiform papillae of all or a portion of the medial dorsum. It usually comes on insidiously and without demonstrable cause; is asymptomatic and unimportant clinically; may remain for

weeks or years, and is resistant to treatment. The failure of normal exfoliation of cellular scales results in the harboring of great numbers of bacteria in the abnormal papillary tufts. These bacteria may be staphylococci, streptococci, yeast, spore formers or a Leptothrix, but when a Penicillium such as *Mucor niger* is present, the color may be black. It is believed that this is coincidental to the coating.

Other causes of the hyperkeratosis include the use of oxidizing agents (such as sodium perborate), the presence of a hyperacidity or of a gastritis with or without hyperacidity (including neoplasm), irritating mouthwashes or fever. Other possible causes of the dark coloration include the presence of silver nitrate, tannic acid, ferric chloride in the presence of blood and dark coloring matter in medicaments or food.

There is no relationship between black tongue of man and that of dogs (which is caused by a vitamin deficiency).

The literature suggests the use of scrapers and salicylates to rid the tongue of the excess tissue, but indicates that this is not remarkably effective.

If the case is not responsive to hygienic measures, it is suggested that local applications of thymol or its isomer carvacrol be used. Thymol is effective against molds, is only slightly soluble in water and is highly effective as a mouthwash in saturated solution (1:1,000).—Queries and Minor Notes, *J.A.M.A.* 111:960, September 3, 1938.

M. K. Hine.

Tooth Ring Analysis. IV Neonatal Dental Hypoplasia: Analysis of the Teeth of an Infant with Injury of the Brain at Birth

By Isaac Schour and Rudolf Kronfeld

Neonatal adjustment and the event of birth itself probably produce profound tissue changes, which are eliminated by later growth and development. In the teeth, however, a permanent record is calcified for interpretation. The birth record leaves a line in the enamel and dentin, the neonatal ring, which is accentuated in accordance with the severity of the birth disturbance. The authors analyzed the calcification record in the teeth of an infant dying at 7 months and 5 days of a brain injury suffered at birth. Roentgenologic examination showed a state of calcification corresponding to that ordinarily found at 6 months of age. The neonatal injury to the enamel-forming cells was so severe that in most of the deciduous teeth the neonatal ring and the surface coincided. Only in the mandibular deciduous cuspids and second deciduous molars did amelogenesis continue after birth. The dentin-forming cells recovered to a greater degree, and although the predentin present at birth never calcified, other dentin was laid down and calcified on its pulpal side. A deviation in the course of the tubules was seen at the neonatal line, and a dentinal plexus, similar to that at the dentino-enamel junction, had been formed there. Neonatal odontoceles, irregular masses of calcified tissue protruding from the dentin into the overlying connective tissue and spreading mushroom-like over the occlusal surface, were found on each maxillary second deciduous molar. The enamel of the mandibular first permanent molar was hypoplastic and the dentin showed dentinal changes similar to those in the deciduous teeth. Two small circumscribed odontomes were found in the overlying connective tissue. The chronology of the teeth is recorded and an earlier age of calcification and formation than has been reported was indicated. The study indicates that the forming and calcifying dental tissues are sensitive to systemic disturbances and afford a permanent accurate record of development.—*Arch. Path.*, 26:471, August 1938.

Hamilton Robinson.

Further Observations Regarding Familial Multilocular Cystic Disease of the Jaws

By W. A. Jones

A condition characterized "by marked protuberance of the cheeks and jaws, and a slight fullness and upward turning of the eyes, revealing the white of the sclera beneath" is described in four of five members of one family. Of five children of 18 months, 7, 10, 11 and 12 years of age, the three oldest showed great involvement of both sides of the maxillae and mandible, the 7-year-old child was apparently normal and the youngest showed roentgenographic evidence of early change. The children were of normal intelligence, and no systemic factor could

be identified. The dentition was irregular. In early stages of the disorder (from 3 to 5 years of age), the children have a cherubic expression and the author suggests the descriptive term "cherubism." A chronic hyperplasia of the cervical submaxillary lymph nodes accompanied the cystic disease. Toward the end of the second year of life, the condition started with painless bilateral swelling of the maxillae and mandible. Roentgenographically, multiple radiolucent areas with heavy trabeculae were noted, giving the general appearance of multiple cysts with heavy bony septa between. The cysts were not examined histologically. An epuloid growth which developed on the alveolar ridge of the mandible in one child was reported as "composed of granulation tissue which is extensively infiltrated with inflammatory cells, many of which are polymorphs." An enlarged lymphatic gland showed a tendency to fibrosis and a proliferation of endothelial cells. No familial history of the disease was found, although a similar case of P. J. Thomas was traced back in an unbroken line for five generations. However, Thomas' case was not identical with the author's. The author believes the condition to be an anomalous development of dental structures. Sterilization of the victims is suggested to prevent passing on of the faulty genes.—*Brit. J. Radiol.*, 11:227, April 1938.

HAMILTON ROBINSON.

Historadiography

By P. LAMARQUE

THE use of X-rays in the field of histology as a means of analysis of tissues by classification according to degree of density is described. The text further states that when the photographic emulsions are perfected, greater enlargement of roentgenograms will be possible. X-ray "scatter" is, of course, the one factor that limits this field.—*Brit. J. Radiol.*, 11:425, July 1938.

B. J. FREY.

Dermatitis and Stomatitis from the Mercury of Amalgam Fillings

By E. F. TRAUB and R. H. HOLMES

Two cases of mercurial stomatitis and dermatitis following the insertion of amalgam fillings are reported. No generalized systemic manifestation occurred in either case. Local symptoms had disappeared within a week. The opinion is expressed that, during insertion of the filling, "considerable amalgam generally adheres to the dentist's hands and this in turn is rubbed on the patient's skin around the mouth, producing direct contact." The authors add that "in those cases in which acute dermatitis or stomatitis occurs, the process is undoubtedly due to contact rather than absorption of mercury, as is intimated in some of the reported cases." —*Arch. Derm. & Syph.*, 38:349, September 1938.

FRANK ALLEN.

Lichen Planus of the Lips

By D. W. MONTGOMERY

ALTHOUGH lichen planus rarely occurs on the lips, in those cases in which the lips are involved, the lower lip is most frequently affected. Important as a diagnostic aid is the almost unfailing involvement of the mucous membrane of the cheeks. Although lichen planus of the cheeks is definitely papular, papules seldom occur on the lips. This, the author believes, is due to the semimucous, corneous covering of the vermilion portion of the lip, which tends to obscure the characteristic milk-white lesion on the cheek. The labial lesion may become eroded and form a band extending along the top (contacting portion) of the lip, or it may become still more intense and cause extensive cheilitis, with a heavy, purulent discharge.—*Arch. Derm. & Syph.*, 38:401, September 1938.

FRANK ALLEN.

Some Direct Measurements of the Gamma Ray Dose Delivered to Malignant Lesions of the Tongue by Interstitial Radiation

By C. W. WILSON and S. CADE

DIRECT measurement of the dosage delivered to the tongue by interstitial radium therapy reveals that the minimum dose assuring a satisfactory clinical result is of the order of 5,000 r. In many cases, however, the minimum value reaches the order of 10,000 r., whereas those parts of the lesion near the needles may receive very much more than this. The results also suggest

that the threshold dosage rate for squamous-cell carcinoma must be below 0.473 roentgens per minute.—*Brit. J. Radiol.*, 11:599, September 1938.

JOSEPH VOLKER.

Congenitally Missing Teeth

By J. T. QUINTERO

THE most frequent missing teeth are, first, the upper lateral incisors, then the lower second bicuspids and, third, the third molars. The central incisors are rarely missing and the cuspids are almost never absent. The author's opinion is that orthodontic treatment in such cases involves the maintenance of the symmetry of the dental arch.—*D. Rec.*, 58:473, September 1938.

B. J. FREY.

Relationship of Oral Thrush to Vaginal Mycosis and Incidence of Each

By P. W. WOODRUFF and H. C. HESSELTINE

IN a study on the incidence of oral thrush in 14,640 consecutive babies delivered at the Chicago Lying-In Hospital with relation to the occurrence of vaginal mycosis in the mothers, clinical diagnosis was confirmed in each case by direct smear and/ or culture. The incidence in the third trimester of pregnancy, 28 per cent, appears to be related to the economic level and individual hygiene. Children born of mothers having fungi in the vagina have about a thirty-five times greater chance of developing oral thrush than those born of non-infected mothers. The incidence of oral thrush in new born babies is about 1 per cent.—*Am. J. Obst. & Gynec.*, 36: 467, 1938.

JOSEPH VOLKER.

Zahnfleischerkrankungen Bei C-Hypovitaminosen (Inflammation of Gums in Vitamin C Deficiency)

By K. MORGENROTH

EIGHTY-FIVE children, aged 6-15 years, were studied from October until April. They were divided into two groups on the basis of vitamin C intake, one group being saturated, the other definitely deficient as shown by urinalysis for ascorbic acid. Results: Among the children given sufficient vitamin C, fourteen boys and an equal number of girls were found to be free from gingivitis, a percentage of 68.3; five boys and five girls had marginal gingivitis (percentage, 24.4), and two boys and one girl had diffuse gingivitis (percentage, 7.3). Among the children without sufficient vitamin C intake, nine boys and twelve girls were free from gingivitis (percentage, 27.7); ten boys and five girls had a marginal gingivitis (percentage, 34.1), and three boys and five girls had diffuse gingivitis (percentage 18.2).—*Deutsche Zahnarztl. Wchnschr.*, 37:872, 1938.

MARTIN DEAKINS.

Black Hairy Tongue: Preliminary Observations on Two Cases

By PAUL PINCUS and BRIAN BOYD-COOPER

COLORED tongues vary in type from those showing pigmentation without hair to those with heavy growths. Males are more affected than females, the cause of this being unknown. Scrapings from one case on culture showed a black colony, the pigment resembling a melanin. Attempts at subculture failed. Cultures of scrapings from a second case were unsuccessful. Microscopic examination of the organism revealed budding, nucleated, yeast-like cells, strongly staining, and gram-positive. It is thought that the organism probably belongs to the group of *fungi imperfecti* classified by Saccardo as Hyphomycetes subgroup Dematiaceae.—*Brit. D. J.*, 65:271, September 1, 1938.

L. H. GARRISON.

Examiners and Grading

THE selection of students for professional schools, under the present-day educational system, is usually determined by their "grades." Hutchinson and Pugh have shown large variations in the grades given by different examiners, or by the same examiner at different times—in the same subject, of course. Apparently, examiners differed among themselves as much as did the students.

A person's success or failure in a professional school is highly correlated with his college record. The colleges vary, however, in scholastic standing and correction factors have been developed to reduce the differences. The editorial suggests a further correction to eliminate unjustified variation in

grading by the examiners. One might suggest also the use of a correction factor for the variation in grading by examiners *within* the professional school.—Editorial, *J.A.M.A.*, 111:848, August 27, 1938.

MARTIN DEAKINS.

Roentgenographic Diagnosis of Vital Pulp Infection

By M. J. FUENDELING and T. L. CARTNEY

THAT the basis of roentgenographic interpretation is the recognition of changes in the contour of the pericemental membrane and variations in the density and structure of cancellous bone was confirmed by extraction of the tooth and a bacteriologic study of the pulp tissue. Bacteriologic findings in 100 cases of vital pulp infection are reported. In more than 86 per cent of the cases, a microaerophilic type of organism was recovered.—*Am. J. Roentgenol. & Rad. Therap.*, 40:386, 1938.

JOSEPH VOLKER.

Studies on Dental Caries. III A Method of Determining Posteruptive Tooth Age

By C. E. PALMER, HENRY KLEIN and M. KRAWER

THE eruption dates of the permanent teeth of 4,416 children were studied in detail. It was possible to show that the relation between the chronologic age and the average posteruptive tooth age of all permanent teeth (exclusive of third molars) was greater in girls than in boys. This difference was approximately 8 per cent when both groups had reached the age of 14.5 years.—*Growth*, 2:149, August 1938.

JOSEPH VOLKER.

Dental Practice Acts: Board Exercises Administrative Functions in Revoking License

A STATE board of dental examiners, said the district court of appeal, first district, division 1, California, exercises discretionary administrative functions, not judicial functions, in revoking licenses to practice dentistry. Neither a writ of prohibition nor a writ of certiorari, therefore, may be utilized to obtain a court review of a revocation order. Jacobs vs. Board of Dental Examiners (Calif.) 75 P. (2d) 96.—*J.A.M.A.*, 111:968, September 3, 1938.

MARTIN Deakins.

Zinc Peroxide in Mouth Infections

By J. P. WINTRUP

FROM the results of treating ten acute cases of Vincent's infection, eight cases of chronic Vincent's infection, twelve cases of acute gingivitis, three cases of suppurative periodontoclasia and two cases of radiation necrosis, zinc peroxide seems to be quite effective. The agent contains nearly as much oxygen as sodium perborate and evolves it slowly, thus prolonging the action. It is applied in paste form and remains in place longer than many other medicaments. Complete directions for its use are given.—*Surgery*, 4:1, July 1938; abstr. *J.A.M.A.*, 111:876, August 27, 1938.

MARTIN DEAKINS.

Lessened Incidence of Caries When Casein Replaces Milk in the Coarse Corn Meal Diet

By C. A. LILLY

HOPPERT, Weber and Canniff *(Science*, 74: 77, 1931) reported that from 90 to 100 per cent of rats developed caries on the following diet: coarsely ground yellow corn meal, 60 per cent; whole milk powder, 30; linseed meal, 6 per cent; alfalfa meal and sodium-chloride 1 per cent. Altering this diet by replacing the milk powder with commercial casein the author was able to reduce the incidence to 10⅔ per cent. The question as to what causes this inhibitory action is raised by the author.—*Proc. Soc. Exper. Biol & Med.*, 38:398, 1938.

VIRGIL D. CHEYNE.

Evipan in Dental Surgery

By O. P. CLARK

A MORE widespread use of evipan for anesthesia in dental surgery is suggested. The anesthestic is administered intravenously at a rate of about 1 cc. in fifteen seconds. The usual dosage is about 10 cc. The stomach should be empty before administration. Premedication with pentobarbital is of aid in alcoholic cases. Recovery occurs in from ten minutes to one hour.—*Cur. Res. Anes. & Anal.*, 17:286, 1938.

JOSEPH VOLKER.

BIBLIOGRAPHICAL

Accepted Dental Remedies (1938)

Containing a list of official drugs selected to promote a rational dental materia medica, and descriptions of acceptable nonofficial articles. Council on Dental Therapeutics, American Dental Association, 212 East Superior Street, Chicago, Ill. Price $1.00.

Now in its fourth edition, Accepted Dental Remedies (1938) is a notable contribution to dental therapeutics, epitomizing the efforts of the Council on Dental Therapeutics to attain one of the primary objects of the Council—"protecting the dental profession and the public against fraud or imposition, undesirable secrecy and objectionable advertising in connection with the marketing of proprietary dental articles."

A.D.R. lists all drugs that have proved acceptable according to standards prescribed by the Council.

The book is increasing in size with each new edition, now containing 284 pages of information relating to dental therapeutics that should be in the hands of every practicing dentist. As an example of the practical usefulness of Accepted Dental Remedies to the dental practitioner, there is published in the latter part of the book an extensive list of formulas of preparations recommended for dental use and which may confidently be prescribed as true and tried remedies for dental diseases, with the assurance that these formulas can readily be compounded by any dependable pharmacist.

This feature of the book represents a supplementary effort on the part of the Council to encourage dentists to use and prescribe remedies that are well-tried and well-proved.

At a time when efforts are being made to more intensively develop the medical aspects of dental practice, Accepted Dental Remedies may readily serve the dentist as a *vade mecum* in the application of therapeutics to dental disease.

Although the book continues to enlarge, the price remains $1.00.

Books Received

The American Illustrated Medical Dictionary (Eighteenth Edition)

The American Illustrated Medical Dictionary. A complete dictionary of the terms used in Medicine, Surgery, Dentistry, Pharmacy, Chemistry, Nursing, Veterinary Science, Biology, Medical Biography, etc. By W. A. Newman Dorland, A.M., M.D., F.A.C.S., Lieut.-Colonel, M.R.C., U.S. Army; Member of the Committee on Nomenclature and Classification of Diseases of the American Medical Association; Editor of the "American Pocket Medical Dictionary." With the Collaboration of E. C. L. Miller, M.D., Medical College of Virginia. Eighteenth Edition, revised and enlarged. 1,607 pages with 942 illustrations, including 283 portraits. Flexible and stiff binding. Philadelphia and London: W. B. Saunders Company, 1938. Plain, $7.00 net. Thumb Indexed, $7.50 net.

Practical Pedodontia or Juvenile Operative Dentistry and Public Health Dentistry. An Introductory Text for Students and Practitioners of Dentistry.

By Floyde Eddy Hogeboom. D.D.S., F.A.C.D., Professor of Children's Dentistry, College of Dentistry, University of Southern California. Former member Health and Development Department, Pasadena City Schools. Former member of Children's Hospital Staff, Los Angeles. Consultant to Orthopaedic Hospital, Los Angeles. Chairman, Dental Assistant's Course, Los Angeles Junior College, Los Angeles 1930-1937. Special Chapters by Forrest Anderson, M.D., Sc.D. (Med.), Director, Child Guidance Clinic of Los Angeles and Pasadena. Lecturer in Mental Hygiene, University of California, and College of Dentistry, University of Southern California.

HAROLD HAWKINS, D.D.S., Former Associate Professor of Bacteriology and Preventive Dentistry, College of Dentistry, University of Southern California.

THADDEUS P. HYATT, D.D.S., F.A.C.D., Professor of Preventive Dentistry, New York University, College of Dentistry. Former Director, Dental Department, Metropolitan Life Insurance Company.

HARRY E. STRAUB, D.D.S., Special Instructor in Exodontia and Minor Surgery. Former Faculty Member College of Dentistry, University of Southern California. Fourth Edition. St. Louis: The C. V. Mosby Company. 1938. Price $6.50.

Nutrition of the Infant and Child

By JULIAN D. BOYD, B.S., M.S., M.D., Associate Professor of Pediatrics, State University of Iowa. Edited by MORRIS FISHBEIN, M.D., 1937. National Medical Book Co., Inc., New York City. Price $3.00.

A Scrapbook of Dental Informalities

By HERBERT ELY WILLIAMS, D.D.S. Price $3.00.

Fractures of the Jaws

By ROBERT H. IVY, M.D., D.D.S., F.A.C.S., Professor of Maxillo-Facial Surgery, School of Medicine and Graduate School of Medicine, and of Clinical Maxillo-Facial Surgery, School of Dentistry, University of Pennsylvania; Chief of Maxillo-Facial Surgery, Graduate Hospital; Consultant in Plastic Surgery, Children's Hospital, Philadelphia; Oral Surgeon to the Presbyterian Hospital; Colonel, Medical Officers' Reserve Corps, U. S. Army.

LAWRENCE CURTIS, A.B., M.D., D.D.S., F.A.C.S., Assistant Professor of Maxillo-Facial Surgery, Graduate School of Medicine, and School of Dentistry, University of Pennsylvania; Visiting Chief of Maxillo-Facial Surgery, Philadelphia General and Delaware County Hospitals; Associate in Oral Surgery, Presbyterian Hospital. Second Edition, Thoroughly Revised. Illustrated with 199 engravings. Philadelphia: Lea & Febiger. 1938. Price $4.50.

Bacteriology for Dental Students

By ARTHUR BULLEID, L.R.C.P. (Lond.), M.R.C.S., L.D.S. (Eng.), Dental Surgeon and Lecturer in Special Bacteriology to the Dental School, Guy's Hospital. With 24 Plates, one of which is colored, and 36 illustrations in the text. Second edition. St. Louis: The C. V. Mosby Company. 1938. Price $4.75.

Hodgen-Shell Dental Materials

By JOHN S. SHELL, B.S., M.A., Director of Research and Development, Thomas J. Dee & Company; Formerly Assistant Professor of Chemistry and Metallurgy, College of Dentistry, University of California. Illustrated. St. Louis: The C. V. Mosby Company. 1938. Price $4.50.

General Bacteriology

By EDWIN O. JORDAN, Ph.D., Late Andrew McLeish Distinguished Service Professor of Bacteriology in the University of Chicago. Revised by WILLIAM BURROWS, Ph.D., Assistant Professor of Bacteriology in the University of Chicago. Twelfth Edition, revised. Fully Illustrated. Philadelphia and London: W. B. Saunders Company. 1938. Price $6.00.

A Textbook of Physiology

By WILLIAM D. ZOETHOUT, Ph.D. Professor of Physiology in the Chicago College of Dental Surgery (Loyola University). Sixth edition. With 291 illustrations. St. Louis: The C. V. Mosby Company. 1938. Price $4.00.

Text-Book of Histology for Medical Students

By EVELYN E. HEWER, D.Sc. (Lond.) (Reader in Histology in the University of London and Assistant Lecturer in Physiology at the London [Royal Free Hospital] School of Medicine for Women). St. Louis: The C. V. Mosby Company. 1938. Price $4.50.

Essentials of College Chemistry

By G. H. WHITEFORD, Professor of Chemistry; and R. G. COFFIN, Associate Professor of Chemistry, Colorado State College. St. Louis: The C. V. Mosby Company. 1937. Price $4.00.

PRACTICE IN PARAGRAPHS

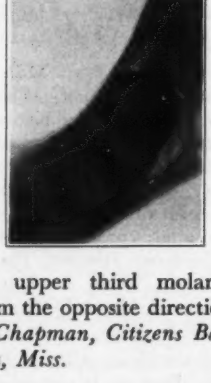
This department is intended for busy readers. It aims to tell a vivid story in a few words. Items should be of a practical character, and free from padding—not more than a paragraph or two. We exact no limit, but two hundred words can tell most of these stories. Send in your ideas; they will be welcome.

A Dental Anomaly—The anomaly shown in the accompanying roentgenogram consists of an upper right second molar and an upper right third molar, the roots of which are interdigitated and inextricably fused. The third molar was completely impacted. Both were extracted from the mouth of a woman, aged 76. A local anesthetic was used. No gingival incision was necessary, the third molar

being luxated into and through the alveolus of the second molar. The radiolucent area in the third molar is not caries, but indicates the honeycomb formation of the enamel. There was also a slight amount of honeycombing of the apex of the mesiobuccal root of the second molar. Healing was uneventful. —*Albert E. Rigberg, 4 South Center St., Pottsville, Pa.*

Quick Drying Roentgenogram—When, in emergencies, a film must be exposed, processed and sent to a fellow practitioner, much time can be saved by drying with alcohol. Immediately after fixation and washing, the film, still on its clip, is placed in a glass of alcohol for about one minute and then hung in the sun or in front of a fan. If dried with alcohol, it can be placed in an envelop and sent out immediately.—*James A. Matthews, Glen Cove, N. Y.*

Unusual Third Molar Impaction—A woman aged 32, whose mouth showed no apparent abnormality, asserted that the upper right second molar had not erupted. Investigation revealed that this molar was very much out of line and



that the upper third molar, bearing down from the opposite direction, met it. —*J. H. Chapman, Citizens Bank Bldg., Columbia, Miss.*

Rapid Successful Fitting of Plain Davis Crowns to Roots with Greatly Enlarged Canals.—A screw post such as is used to reinforce large amalgam fillings in devitalized teeth and of proper gage is fitted to the root canal. If necessary, the depth of canal or the apical diameter portion is modified accordingly so that

the post will touch the canal wall when rotated. The square head of the post is beveled to fit the hole in the crown and lateral edges of the head are nicked with wire-cutting pliers. The threaded portion of the post is dipped in a thin mix of silicophosphate stone cement and the post screwed in place in the canal root. The fitted crown is cemented to the surface of the root and the modified head of the post with a medium thick mix of the same kind of cement. A plain Davis crown so placed will stay in place and is extremely rigid in the mouth.—*G. Sidney Jacks, Chicago, Ill.*

Rust Remover—A small amount of wet laboratory pumice worked into the joint of sticky forceps will remove all rust and restore the flexibility of the joint. No lubricant is needed.—*C. H. Bartle, New Glarus, Wis.*

INCIDENTS OF PRACTICE

Durable Silicate Fillings

By W. Clyde Davis, A.M., M.D., D.D.S., Lincoln, Nebr.

If one will adhere to the following technic, silicate fillings should last a lifetime for the majority of patients, for these rival the best amalgam fillings and are particularly indicated in all Class I, II, III and V cavities and many large bulky Class IV cavities.

The proven reasons for the following statements and technic are too numerous to mention here.

Both the fluid and the powder should be kept from the air as much as possible as all silicates are affected by the air in high or low degrees of humidity.

Three drops of liquid are placed on the slab with a little more powder than is needed. It is useless to attempt to combine a measured amount of both powder and liquid: it will not work.

The temperature of the slab should be 60° F. at the start. Three-fourths the amount of powder is added to the liquid and as soon as this has been incorporated, small additions are made, until the desired consistency has been obtained. In mixing or pushing the end of the spatula into the mix, the silicate dulls, but gloss returns to the mass when patted with the clean part of the spatula. There should be little or no sticking of the mix to the spatula when patted on the slab. Consistency should be our only guide.

The greatest amount of powder possible for complete mortarization is desired. Slight variation of the amount of powder, at will, is the only condition we have under our control to counterbalance other variables not easily controlled. The best silicate fillings are produced at a low humidity and low temperature, with a large amount of powder incorporated in the mix.

When the mix is complete, the mass is patted out flat on the cold slab (now at about 63°) and a glass cover is placed over it to maintain the low temperature.

With the rubber dam in place, the cavity is overfilled, and the material patted and tamped to place, and immediately smeared with oil. All silicate fillings should at this time be placed under from 10 to 15 pounds pressure for fifteen minutes, and then trimmed with knives, files and burs to the desired contour. The rubber dam should not be removed for thirty minutes after the mix is begun. The instruments and appliances to make pressure on fillings of all Classes, I, II, III, IV, V and mesioclusodistal, are easily made by the dentist. They cannot be had on the market.

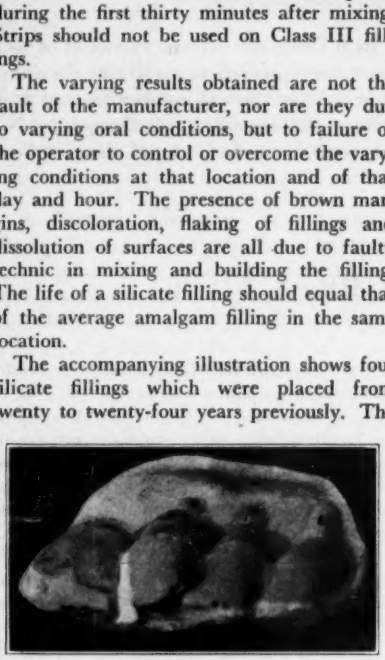
The day this was written, I saw two silicate fillings that were inserted in 1910 (twenty-eight years ago), one on the gingival surface of an upper cuspid, the other a rather large filling on the occlusal surface of the upper right first molar. Neither needed replacement or repair.

All silicates shrink most in the first fif-

teen minutes and should be under pressure during that time and be coated with oil. The surfaces of all silicates expand if exposed to moisture even in a saturated atmosphere during the first thirty minutes after mixing. Strips should not be used on Class III fillings.

The varying results obtained are not the fault of the manufacturer, nor are they due to varying oral conditions, but to failure of the operator to control or overcome the varying conditions at that location and of that day and hour. The presence of brown margins, discoloration, flaking of fillings and dissolution of surfaces are all due to faulty technic in mixing and building the filling. The life of a silicate filling should equal that of the average amalgam filling in the same location.

The accompanying illustration shows four silicate fillings which were placed from twenty to twenty-four years previously. The



Four silicate fillings (center indicated by black dots).

three teeth have been badly worn by the toothbrush, yet the silicate fillings stand up above the present surface. There is no decay nor discoloration about the fillings.

814 Security Mutual Building.

Immediate Denture Service

By Arthur D. Barker, D.D.S., Grand Mound, Iowa

Fortunately for all concerned, the innovation in dental practice known as immediate full denture service has proved to be both practical and highly desirable. The object of this paper is to help bring the benefits of this service within reach of the greatest number of people.

The following are a few of its advantages:

1. The dreaded toothless period is eliminated.

2. Retaining a properly adjusted denture in contact with the fresh wounds of extraction is not painful. It actually serves as a protection and support to that area.

3. The customary occlusion relations are never lost, and so do not have to be found again.

4. The operator is enabled to place each artificial anterior tooth in exactly the position occupied by its predecessor, or in exactly such a modification of that position as utility or esthetics may require.

This exactly correct position of each artificial tooth should never be lost by rebuilding the denture. The immediate denture is designed on a strictly "permanent" basis, and the refitting procedure should keep it so. People who do not care for duplicate dentures will submit to short toothless periods for such adjustments, which may include replacement of denture base material if desired.

Steps in Immediate Denture Service

1. Select the teeth by direct comparison of shade and mold guides with the remaining anterior teeth, having due regard for facial types, so as to nearly duplicate, or otherwise properly replace, the natural teeth.

2. Extract the posterior teeth at suitable sittings and wait one to three weeks for healing. The anterior teeth usually register and retain the occlusion; if not, leave one or more posterior teeth in the mouth to insure that result.

3. Take good modeling compound or other impressions to include the labial area. Make two good casts of each jaw to be restored.

4. Register the occlusion with the usual trial plates and wax rims, and mount the working model in a Gysi or other articulator. Use no facebow.

5. If the posterior teeth are to be articulated with a cast of the natural teeth or an old denture, set them up first, and try them in if desired. Open the bite enough to receive anterior teeth of the proper length. If any anterior teeth are in normal position, cut an adjoining tooth from the cast at the alveolar border and adjust the artificial tooth in proper relation to the normal natural one. If there are vacancies on the cast, adjust each tooth to exactly normal position, carving the cast and grinding the new tooth as may be required to insure proper relation to and

snug contact with the ridge when the denture is seated. Wax each tooth securely in the desired position before cutting another tooth from the cast. Place the substitute for each normally placed natural tooth in exactly the same position. Complete the set-up along these lines. Never cut more than one tooth at a time from the cast.

6. Complete the denture, or dentures, in vulcanite or some other material that can be readily refitted to the mouth as resorption may require.

7. Extract the remaining teeth and begin trying in the dentures as bleeding subsides. Remove any excess denture material, grind the teeth and trim the alveolar margins as may be necessary until the denture becomes stable. With some experience, this result can usually be obtained without the aid of impression paste or denture powder for the first night, or at all during the healing period.

In from three to ten weeks, a bite-impression refit is likely to be necessary. There should usually be another in more or less than a year. The refitting includes the addition of a labial rim as Nature makes room for it.

If you will attempt this comparatively simple process, you will be well pleased at the appreciation of patients, and by the satisfaction of seeing them come in with their natural teeth and walk out an hour or so later with perfectly "natural" artificial substitutes in the mouth.

Gas Gangrene Following Tooth Extraction, with Subsequent Recovery: Report of a Case

By Arthur H. Beebe, M.D., Stillman Valley, Ill.

History.—W. McN., a farmer, being treated for chronic valvular heart disease by extraction of infected teeth, had a bicuspid extracted August 5 from a necrotic base. Uneventful progress continued for five days, when, August 11, while assisting with chores, he extracted a fragment of bone with his finger. Three days later, August 14, he went to bed with a dry throat and a myocardial collapse.

Read before the Staff of St. Anthony's Hospital, Rockford, Ill.

Examination and Treatment.—The physician summoned treated his heart. There was no evidence of gas infection. Twenty hours later, on orange-sized lump developed below the angle of the jaw, crepitant and rapidly progressing. There was a mild delirium increasing in severity. The heart was rapid, pounding and irregular. Two hours later, 4 m. units of gas antitoxin was given; four hours later, 20 m. units of gas antitoxin, and ten hours later, another 20 m. units; a total of 44 m. units. After the first dose of antitoxin, the patient sweated profusely. He was in severe delirium, with very erratic heart action, and passed urine in large quantities.

Six hours after the last dose of antitoxin, there seemed to be some slight improvement in the mental condition. The gas infiltration by then had extended well down the shoulder into the arm and over the back and chest. At that time, oxygen was injected into the tissues, deep and superficially, in advance of the infiltration of gas, and all around the area, blocking the advance of the gas bacillus.

Outcome.—Twenty-four hours later, there had been no further advance in the gas infiltration. There had been constant lessening in the thickness and crepitation of the gas areas. The physical and mental condition was greatly improved. From that time on, with careful guarding of the heart muscle, there was steady improvement in all respects. On the fifth day, all signs of gas poisoning had disappeared, the eliminating organs were functioning normally and the heart was improving and recovering from the severe strain. Two weeks later, the patient was released from bed, with good heart action and ready to have more teeth extracted.

Summary.—Recovery from gas bacillus infection, caused by infection of a finger, followed the use of 44 m. units of gas antitoxin and the blocking off of infiltrated areas by oxygen injections.

Pathologic Report (Dr. Padgett).—There was no leukocytic infiltration. There was a large exudate, a decreased blood supply, with toxins causing multiple thromboses with resulting degeneration of striated muscles, necrosis and death of red cells and early circulatory collapse. There was little or no rise in temperature.

MODERN SCIENCE—FRIEND AND FOE

By E. F. Schewe, D.D.S., Huntington Park, Calif.

Mingled emotions of exhilaration and disquietude take possession of many of us when we contemplate modern progress. We are grateful to observe that there is probably nothing more wonderful in the history of mankind than the triumph of pure and applied science in our contemporary world. And this progress is much in evidence in the practical and beneficent achievements of scientific medicine in all its branches. During our lifetime, many of us have seen diseases such as smallpox, tuberculosis, typhoid fever, yellow fever, cholera, diphtheria, tetanus and nephritis conquered or controlled. And it seems that before long, medical science will conquer syphilis and cancer.

Besides, we stand in awed amazement as we contemplate the transformation that has been wrought during the last century by the telephone and telegraph, the radio and the motion picture, applied chemistry and power machinery—a transformation so far-reaching that there is a greater difference between our lives and the lives of our grandparents than there was between their lives and the lives of the Romans at the dawn of our era.

And still, while we rejoice at these extraordinary achievements, we realize with anxiety that something is terribly out of joint. We are witnessing, in our time, the ghastly spectacle of far-flung scientific preparations by all nations for the next war, their armies and navies, sea and air fleets, machine guns and armed tractors, submarines, bombing planes, poisonous gases and chemical concoctions all for the wholesale slaughter of human life. And we note, at first with surprise and then with horror, that capable scientists, engineers, physicists and chemists are engaged in internecine activities in the government workshops and laboratories in every country of the civilized world.

Visualize for a moment a twentieth century battlefield where vast armies, equipped with scientific death-dealing devices, relentlessly move forward to destroy their fellowmen. And then reflect that at the rear of those armies, the Red Cross follows with corps of physicians and nurses, furnished with all the facilities of medical science in sacrificial efforts to restore the mutilated bodies of the victims. The soldier is there to kill, the physician to heal, both equipped with scientific apparatus, the one for death, the other for life. What irony is disclosed in this strange spectacle! Thirty years ago, we hailed science as man's true friend. Today, we are beginning to fear that science is equally man's implacable foe.

Plato said, "There is in each man a beast and a god." So in modern science, there lurks a demon and an angel. Which will be the ultimate master? In his latest book, "Star-Begotten," H. G. Wells refers to a situation "when a superman makes an aeroplane and an ape gets hold of it."

Fervently we trust that science may not develop into a fiendish Caliban, or worse still, into a brutal Frankenstein, equipped with limitless power, but destitute of heart and soul, of pity and love. In the end, it would wreck the magnificent civilization that it has so laboriously built up.

However, if science becomes an angelic force, a sprightly Ariel who is inspired and directed by dynamic spiritual powers, it will enable humanity to escape the "Tempest," and to fulfil its high destiny.

6339½ Pacific Boulevard.

DEATHS

Brittin, Roy Clay, Dallas, Texas; George Washington University, Dental Department, 1906; died August 8; aged 61.

Cleaver, Louis K., Johnstown, Pa.; Temple University School of Dentistry, 1898; died July 11; aged 62.

Coogan, W. H., Bryn Mawr, Pa.; Temple University School of Dentistry, 1901; died January 15.

Cooper, Rose, Indianapolis Ind.; Indiana University School of Dentistry, 1898; died June 28.

Cote, Dana J., Iron Mountain, Mich.; University of Michigan, College of Dentistry, 1916; died July 17.

Crego, Walter L., Saginaw, Mich.; University of Michigan, College of Dentistry, 1902; died June 4.

Crissey, Willis S., South Fork, Pa.; University of Pittsburgh, School of Dentistry, 1922; died recently; aged 40.

Cummins, Frank L., Plattsmouth, Nebr.; Northwestern University Dental School, 1901; died August 21.

Elofson, O. W., Longmont, Colo.; School of Dentistry, University of Denver, 1927; died recently.

Englert, George A., Tampa, Fla.; School of Dentistry, University of Pennsylvania, 1885; died September 1; aged 81.

Ersner, William B., Philadelphia, Pa.; Temple University School of Dentistry, 1916; died June 13.

Frazier, Sayles J. B., Philadelphia, Pa.; Temple University School of Dentistry, 1901; died August 23.

Gamble, E. Russell, Philadelphia, Pa.; Temple University School of Dentistry, 1892; died July 14.

Gorder, R. M., Longmont, Colo.; School of Dentistry, University of Denver, 1918; died recently.

Gossett, Henry S., Independence, Mo.; Kansas City-Western Dental College, 1900; died September 14; aged 61.

Gough, Frank A., Brooklyn, N. Y.; University of Buffalo, School of Dentistry, 1897; died August 15; aged 66.

Harper, William E., Chicago, Ill.; Northwestern University Dental School, 1891; died August 17; aged 73.

Hepworth, John T., Wappingers Falls, N. Y.; Baltimore College of Dental Surgery, 1904; died July 7; aged 70.

Hopfer, Martin H., Omak, Wash.; Kansas City-Western Dental College, 1892; died October 3.

Johnson, William A., Salem, Ore.; North Pacific College of Oregon, School of Dentistry, 1919; died August 19.

La Croix, H. A., Denver, Colo.; School of Dentistry, University of Denver, 1914; died recently; aged 51.

Maurer, Vernon C., Massillon, Ohio; College of Dentistry, Ohio State University, 1920; died April 4; aged 40.

Mitchell, Harry L., Montrose, Colo.; School of Dentistry, University of Denver, 1923; died recently.

Morgan, Owen, Johnstown, Pa.; Baltimore College of Dental Surgery, 1895; died July 17; aged 71.

Nieman, B. F., Indianapolis, Ind.; Indiana University School of Dentistry, 1914; died July 7.

Ogle, Clifford C., Lincoln, Ill.; Indiana University School of Dentistry, 1904; died recently.

Reece, John S., Bloomington, Ill.; Northwestern University Dental School, 1901; died June 18; aged 68.

Robey, W. Marvin, Charlotte, N. C.; Vanderbilt University, School of Dentistry, 1901; died July 19; aged 59.

Smith, Thomas Hutchinson, Bloomington, Ill.; University of Pittsburgh Dental College, 1906; died June 5; aged 59.

Squires, R. M., Wake Forest, N. C.; School of Dentistry, Medical College of Virginia, 1904; died August 14.

Stahl, Charles H., Chicago, Ill.; Northwestern University Dental School, 1887; died July 21; aged 73.

Swift, Arthur Lessner, Stamford, Conn.; New York College of Dentistry, 1885; died August 5; aged 77.

Swing, Charles W., Philadelphia, Pa.; School of Dentistry, University of Pennsylvania, 1912; died September 17.

Thompson, David L., Denver Colo.; School of Dentistry, University of Denver, 1922; died recently; aged 40.

ANNOUNCEMENTS

ANNOUNCEMENTS must be received by the fifth day of the month in order to be published in the forthcoming issue of THE JOURNAL.

CALENDAR OF MEETINGS

American Society for the Advancement of General Anesthesia in Dentistry, New York City, fourth Monday in March and October.

Dental Protective Association of the United States, Chicago, December 19.

Five State Post Graduate Clinic, Washington, D. C., March 5-9.

Great Lakes Association of Orthodontists, Cleveland, Ohio, November 7-8.

Greater New York Dental Meeting, New York City, December 5-9.

National Board of Dental Examiners, December 2-3.

North Atlantic Orthodontic Society, New York City, November 18.

Allied Dental Council, New York City, November 2-5.

Chicago Dental Society, February 13-16, 1939.

Greater Philadelphia Annual Meeting, February 1-3, 1939.

District of Columbia Dental Society, second and fourth Tuesdays in each month from October to June, at the United States Public Health Service Auditorium, Washington.

Marquette University Dental Alumni Association, Milwaukee, Wis., November 11-12.

American Dental Society of Europe, Lausanne, Switzerland, August 7-9.

STATE SOCIETIES

November

Florida, at Jacksonville (10-12)
Ohio, at Cleveland (24-30)

February

Minnesota, at Minneapolis (21-23)

May

Tennessee, at Nashville (8-11)

STATE BOARDS OF DENTAL EXAMINERS

California, at San Francisco, December 5. Kenneth I. Nesbitt, 515 Van Ness Ave., San Francisco, Secretary.

Connecticut, at Hartford, November 29-December 3. Almond J. Cutting, Southington, Recorder.

Indiana, at Indianapolis, November 14. J. M. Hale, Mt. Vernon, Secretary.

Louisiana, at New Orleans, December 14-17. Joseph L. Webre, 740 Audubon Bldg., New Orleans, Secretary.

New Jersey, December 5-10. Walter A. Wilson, 148 W. State St., Trenton, Secretary.

Pennsylvania, at Philadelphia and Pittsburgh, December 6-10, W. A. McCready, 1115 Highland Bldg., Pittsburgh, Secretary.

South Dakota, at Sioux Falls, January 3-7. Carl H. Boyden, Mitchell, Secretary.

Texas, at Dallas, November 14-17. B. Carl Holder, 1009 Nixon Bldg., Corpus Christi, Secretary.

Wisconsin, at Milwaukee, December 12-16. S F. Donovan, Tomah, Secretary.

TENNESSEE STATE DENTAL ASSOCIATION

The Tennessee State Dental Association will hold its seventy-second annual meeting May 8-11, 1939, at the Hotel Hermitage, Nashville.

HOWARD M. TAYLOR, *Secretary*,
206 Medical Arts Bldg.,
Knoxville.

PENNSYLVANIA STATE BOARD DENTAL EXAMINATIONS

The Pennsylvania State Board dental examinations will be held in Philadelphia and Pittsburgh, December 6-10.

W. A. MCCREADY, *Secretary*,
1115 Highland Bldg.,
Pittsburgh.

GREATER NEW YORK DENTAL MEETING

The fourteenth Greater New York Dental Meeting will be held December 5-9 at the Hotel Pennsylvania, New York City.

GEORGE C. DOUGLASS,
Room 106A,
Hotel Pensylvania,
New York City.

FIVE STATE POST GRADUATE CLINIC

The Five State Post Graduate Clinic, sponsored by the District of Columbia Dental Society, will be held March 5-9, 1939, at the Mayflower Hotel, Washington, D. C.

A. G. MILLER, *Chairman,*
Publicity Committee,
1726 Eye St. N.W.,
Washington, D. C.

SOUTH DAKOTA BOARD OF DENTAL EXAMINERS

The South Dakota State Board of Dental Examiners will hold its next examination at the Carpenter Hotel, Sioux Falls, January 3-7, 1939. Applications should be in the hands of the secretary ten days before the date of the board meeting. For further information, apply to

CARL H. BOYDEN, *Secretary,*
Mitchell.

DENTAL PROTECTIVE ASSOCIATION OF THE UNITED STATES

The annual meeting of the Dental Protective Association of the United States will be held December 19 at the Palmer House, Chicago, at 4 p.m. The report of the officers will be given; a board of directors will be elected and such other business as may come before the association will be considered and acted on, including the matter of applying the assets of the association to the establishment of a trust in commemoration of the founder of the association, Dr. J. N. Crouse, for the purpose of promoting dental research or some other worthy object. All members are urgently requested to be present at this meeting.

By order of the board of directors: D. M. Gallie, president and treasurer; P. G. Puterbaugh, vice president, and E. W. Eliot, secretary.

UNITED STATES PATENTS APPLICABLE OR PERTAINING TO DENTISTRY ISSUED DURING AUGUST AND SEPTEMBER 1938

August 2

No. 2,125,573, to ISAAC D. KELLEY. Atomizer.

August 9

No. 2,126,308, to SAMUEL R. BUTLER. Clamp.

August 16

Des. 110,928, to TOMLINSON I. MOSELEY. Design for electric toothbrush.

Des. 110,936, to ADOLPH D. WISEMAN. Design for dental applicator.

September 6

No. 2,128,917, to ERNEST C. CROCKER. Tooth paste.

No. 2,129,002, to JACOB GOLD. Electric toothbrush.

No. 2,129,040, to VICTOR H. SEARS. Artificial teeth.

No. 2,129,082, to RALPH W. BYRER. Gum massaging appliance.

No. 2,129,212, to GEORGE M. HOLLENBACK. Dental device.

No. 2,129,306, to GLENN T. MITTON. Denture brush.

September 13

No. 2,129,675, to SAMUEL F. COLE. Syringe.

No. 2,129,843, to HEINZ HOLLMANN. Dental or like drill.

No. 2,129,861, to CHARLES DALE MORTON. Lock-pin construction for fixed bridgework.

No. 2,129,922, to JAMES P. FRANCHETTI. Interchangeable facing.

No. 2,130,034, to HANS SCHMIDT. Tooth cleansing agent.

No. 2,130,083, to EDMOND J. FRANWICK. Dental articulator.

No. 2,130,217, to JAMES HERMAN ABBOTT. Napkin holder for headrests.

No. 2,130,244, to TORAZO NISHIO. Method of making a toothbrush.

September 20

No. 2,130,388, to HAROLD CLUCK. Exploring mirror construction.

No. 2,130,406, to ROBERT C. ANGELL. Saliva ejector.

No. 2,130,593, to FRED C. MILLER. Dental press for forming wax patterns.

No. 2,130,656, to JUNZO TAGUCHI. Attachment for artificial teeth.

No. 2,130,661, to ORAN C. ZAEBST. Toothbrush.

September 27

No. 2,131,455, to ERNST O. SCHUTTE. Atomizer head.

No. 2,131,676, to CHARLES H. SEIFERT. Tooth cleaning device.

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1937-1938

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